2-2016

Enhancing travel experience with the combination of information visualization, situation awareness, and distributed cognition

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Graduate School Form 30
Updated 1/15/2015

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Weiran Lei

Entitled

Enhancing Travel Experience with the Combination of Information Visualization, Situation Awareness, and Distributed Cognition

For the degree of Master of Fine Arts

Is approved by the final examining committee:

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Head of the Departmental Graduate Program Date

ENHANCING TRAVEL EXPERIENCE WITH THE COMBINATION OF INFORMATION VISUALIZATION, SITUATION AWARENESS, AND DISTRIBUTED COGNITION

A Thesis

Submitted to the Faculty

of

Purdue University

by

Weiran Lei

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Fine Arts

May 2016

Purdue University

West Lafayette, Indiana

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere gratitude to my adviser and professor, Zhenyu Cheryl Qian, for her patience, persistence, and motivation. Her guidance on this thesis led to the success of both my graduation exhibition and final design. With her support, suggestions, and knowledge, I had the chance to become more confident as a designer, to enjoy focusing on the details, and to be enthusiastic into pursuit of a better user experience in daily life with design approaches.

Second, I would like to thank the rest of my committee members: Steve Vissor and Yingjie Victor Chen. Their wisdom, humor, and insightful advice on my MFA thesis, how to strengthen design proficiency, and even improve my own living encouraged me to think and explore more. I sincerely enjoyed the conversations we had, and the thoughts we shared.

Last but not least, I would like to thank my parents for their support all the way during these past four years. It was a long journey for me to learn so many things as a foreign student in the United States. What I have seen and experienced is precious and meaningful to me as a result of their understanding and suggestions.

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ABSTRACT

Lei, Weiran. M.F.A., Purdue University, May 2016. Enhancing Travel Experience with the Combination of Information Visualization, Situation Awareness, and Distributed Cognition. Major Professor: Zhenyu Cheryl Qian.

With the new forms of travel introduced by new technologies of transportation and communication, a satisfied travel experience could be affected by various factors before and during a trip. Especially for road trips, traveling by car provides freedom on time control while leading to more possibilities of rescheduling initial plans made under time constraints. When overwhelmed with the need for changed travel context to avoid unexpected events that will require a serious change of initial plans, travelers need to find and access helpful contextual information quickly. This is a context-related decision-making process that requires amplifying human situation awareness and supporting distributed cognition, since travel information offers multiple choices. To solve this problem, I applied information visualization as the main design solution. When comparing it with a traditional representation of lists, information visualization displays the advantages of visual representation of abstract data to clarify and depict the information and amplify cognition while improving travel experience intuitively in the domain of user experience design. Therefore in this thesis I will address the approach of implementing recontextualized situation awareness, distributed cognition, and

information visualization in a travel-aid system. By using both theoretical and practical design perspectives, I will discuss how to enhance travel experience with represented contextual information that users desire or expect before and during a road trip. I will also explore the new values of this design with strategic business support. Additionally, after conducting research and analysis on existing interaction design parts, I selected a smartphone app to serve as a proper platform with connected multifunctions. Briefly, I begin the thesis with a review of previous theories and aspects of travel planning, information visualization as it relates to travel, situation awareness, and distributed cognition in the design context and related smartphone apps. Then I discuss the process of identifying the specific issues to be solved or improved with a preliminary research of empirical study, followed by an interview, online survey, insights synthesis, and business model design. After a visual-system design was developed, heuristic evaluation was employed to assess the outcome. Lastly, a new round of refined design results is introduced based on outcomes of the evaluation.

CHAPTER 1. INTRODUCTION

Experiencing a different culture in an unfamiliar place creates novelty in people's otherwise routine lives. This situation is commonly achieved through traveling. Road trips, especially long-distance journeys traveled by automobile, are a popular choice for families and friends. To avoid unexpected events on the road that might cause problems, such as getting lost, lack of information, loss of time and money, and getting caught in bad weather, people tend to plan travel in advance. Yet even with a carefully planned itinerary, complaints like "I went the wrong way," "It's hard to find a gas station," "There's no free parking lot around," and "I wish I could adjust the schedule" are common and frequently heard from travelers. Consequently, it is noted that travel experiences are explored with hopes for improvement.

According to a discussion by Hargreaves & Robertson (2010), planning travel is helpfully reconceptualized as a design activity embedded deeply in the context of everyday life, but it remains an ill-structured problem (Simon & Newell, 1958) that requires human judgment and heuristic thinking processes. However, existing packaged travel information, which refers to a set of destinations, accommodations, and flight options (Hargreaves & Robertson, 2010), is limited by online sources and accessibility as it performs two primary roles: first, an informative role of enquiries and alternatives, and

second, a challenging role, tackling assumed ‘knowledge’ and ‘truths’ (Kenyon & Lyons, 2003). Specifically, a prior planned itinerary for a local road trip may even need changed according to contextual situations.

To improve both the quality of travel experience and people’s understanding of an easily adjusted itinerary, Kenyon & Lyons (2003) suggested increasing awareness of travel options with comfort and convenience to access and comparison. Meanwhile, there is no denying that information visualization (InfoVis) benefits people’s daily lives because visual representation helps to clarify and depict abstract data refined and simplified while aiding human-cognitive tasks (Wong et al., 2006) and travel experience intuitively in the domain of user experience (UX) design. Visualizations of travel information have been applied as a design solution currently plaguing real-time mobile travel technologies.

To support better human performance, a user’s situation awareness (SA) needs should also be improved because it captures a user’s contextual information, including location, time, needs, interests, and social interaction. Meanwhile, on road trips, the interactions between travelers and the contextual environment requires that people adapt to the material world by changing their forms of moving, socializing, and seeing along with further need for assistance to access present information. It also requires people to reorganize their distributed cognition (DCog) systems to make use of a different set of internal and external representations (Hollan et al., 2000) of knowledge and structure in the minds of individuals and in the external environment (Zhang, 1997 & 2006). So the combination of using InfoVis with the theoretical support of distributed cognition (DCog) and improving SA can contribute to a better solution for aiding road trips.

As new theories of planning reflect a shift from classical linear planning models to iterative, deeply contextual models[1], with the increasingly improved value of using mobile devices (such as smartphones) in daily life, an even newer concept with the form of an app on mobile devices, could be the solution. Defined as the development of experience-centric services (Zomerdijk & Voss, 2010) in business literature, experience design could be more innovative with the support of business strategy.

Thus the theme of this design project is to develop a travel-aid system that will integrate digital media with the physical environment and contextual needs to enhance user experience both before and during a road trip. To improve user travel experience, the visualization portion would be challenging when merged into the whole design, especially by means of a small screen display to emphasize that both communication and interaction could be even more challenging. Therefore I propose to build a multifunctional smartphone app, consolidating diverse pieces of an itinerary into a single place. I believe that a contextual-based visualization approach can enhance the travel experience, making it more intuitive, effective, and pleasant.

In the following chapters, I will address the approach of recontextualizing situation awareness and distributed cognition into a travel-aid system while visualizing travel information that users desire or expect before and during a road trip. Besides reviewing existing theories and aspects of travel planning, information visualization,

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[1] Planning travel in the context of everyday activity does not conform to a classical linear planning model. Planning travel is helpfully reconceptualized as a design activity that is iterative, collaborative, social, and at times partial and embedded deeply in the context of everyday life. New theories of planning reflect a shift from classical linear planning models to iterative, deeply contextual models. (Hargreaves & Robertson, 2010, p.24)

situation awareness, and distributed cognition in the design context, I started an empirical field study by practicing “being a tourist” to conceive, record, and reflect tourism experiences. The method of interface criticism was chosen to identify aesthetic aspects of existing travel apps and designs, and heuristic evaluation was adopted to evaluate my design before the final stage of improvement while serving as guidance to the design and implementation. Briefly, the entire process was driven by an iterative design cycle with methodology triangulation to develop a prototyping system design and finally assess the outcome. The cycle includes quantitative and qualitative data collection and analysis through interviews and an online survey, case studies of existing travel systems, design implementation, evaluation, and redesign.

CHAPTER 2. LITERATURE REVIEW

People's travel experience varies; however, when this question arose, "What does travel mean to you?" the answers always led to exploring, experiencing, and enjoying. People believe that travel can help them escape from the everyday routine and become inspired while going with the flow. With new forms of travel brought about by new technologies of transportation and communication (Urry, 1995), a satisfied travel experience can be constructed and affected by different factors before and during a trip. Especially for road trips of long-distance journeys traveled by automobile within a small social group, if unexpected events on the way are to be avoided, both travel planning and the adaptability to the unfamiliar travel contexts require easier and instantaneous solutions catering to the modern methods employed.

Starting with a review of related literature reviews and attempts to discover the relationships among travel, travel planning, travel experience, and user experience design, this chapter is divided into social justification, conceptual justification, and design approach to review existing theories and aspects of travel planning and experience, information visualization, situation awareness, and distributed cognition in design context and business perspective.

2.1 Social Justification

2.1.1 Travel and Travel Experience

In his book *Consuming Places* (1995), John Urry defined that *travel* is intimately bound with an increasing reflexivity about the physical and social worlds. Lamsfus et al. (2013) considered travel a sequential process in which the tourist leaves the daily residence, visits places away from home to interact with different people, and eventually returns to the residence. Central to this process is the idea of mobility, which is of utmost importance because contemporary means of travel afford new ways of moving, socializing, and seeing. And mobility is responsible for altering how people appear to experience the modern world, changing both their forms of subjectivity and sociability and their aesthetic appreciation of nature, landscapes, townscapes, and other societies, thereby transforming the tourist gaze (Urry, 1995; Lamsfus et al., 2013).

In terms of travel experience, argued by Hargreaves & Robertson (2010), it can be explained by the diversity of a traveler's motivations. Wang et al. (2012) described tourist experience as an "activity-based" process, because besides the core activities of tourism, social and environmental activities have been recognized to be important components of the overall touristic experience (Andereck et al., 2006; Wang et al., 2012). Therefore prediction is difficult in travel, since tourists may be unable to make plans for coping with unexpected situations and further to maximize the benefits of their travels (Wang et al., 2012). In other words, the notion of travel context decided the specific need and the necessary information to fulfill that certain situation. That is because as humans, we have the habit of comparing the real experience with the ideal "what is supposed to

be" of our expectations. Hence, on a road trip, the on-the-go journey and time-based activities challenge users' travel behaviors and plans.

2.1.2 Challenges of Travel Planning

With the output usually as a detailed plan, travel planning is later enacted as travel. Creating itinerary scenarios involves making a series of tentative decisions that then allow people to explore the consequences (usually against cost and time constraints) of different courses of action. Here Hargreaves & Robertson (2010) described the process of planning travel as follows:

> (1) Emergence of an initial motivating event
> (2) Seeking inspiration and preliminary research
> (3) Drafting a destination sequence and allocating dates, durations, and activities
> (4) Creating a draft itinerary, research for accommodation and activities
> (5) Iterating an itinerary
> (6) Drafting a budget and an additional iteration (pp. 22-23)

Simultaneously, to generate a good travel plan a traveler may research destinations thoroughly. Although some people enjoy this planning phase, it is clear that constructing a satisfactory trip requires investing significant time and effort. Given limited time, it is impossible to exhaustively search the huge configuration space to design an optimal trip (Savir et al., 2013). Additionally, Hargreaves & Robertson (2010) emphasized that planning travel is taken as a joint planning activity where multiple nascent intentions are formed, communicated, and modified concurrently with information gathering, communication with experts and peers, and the use of planning tools. Granted, it is helpfully reconceptualized travel planning as a design activity that is

iterative, collaborative, social, and at times partial and embedded deeply in the context of everyday life as well (Hargreaves & Robertson, 2010).

Since context is the foundation of travel experience (Lamsfus et al., 2013), the context-related decision-making processes of a road trip require assistance to access and present travel information effectively and to reconfigure a new plan as needed that can match users' situation awareness needs and expectations. Nevertheless, travel planning is also identified as one of a set of ill-structured problems that people encounter as part of everyday life (Simon & Newell, 1958; Hargreaves & Robertson, 2010), which requires human judgment and heuristic thinking processes. According to Rittel (1972), ill-structured problems:

> …are often difficult to define as they frequently consist of multiple competing goals, some of which are declared and others undeclared; their goals may be redefined or may emerge as the activity progresses or as new information becomes available, and they may be multiple competing solutions.…ill-structured problems have the following properties: each new problem is essentially unique; each problem becomes a symptom of another problem; improving aspects of the world in which people live replaces a search for truth as an intent. (Rittel, 1972; Hargreaves & Robertson, 2010, pp.21)

In short, to solve an ill-structured problem, Rittel (1972) points to the development of computational systems that can match heuristic thinking and judgments.

When it comes to searching and organizing travel information as essential steps of travel planning, Kenyon & Lyons (2003) discussed the traveler's modal changes, based on the idea that different levels of information will be shown at different times, ranging from simple financial cost and journey duration information to information incorporating comfort and convenience factors. Their research showed that a traveler's choice is automatic and habitual, based on subconscious perceptions of the viability and

desirability of travel by modes other than the dominant mode (Kenyon & Lyons, 2003). With a modal named Integrated Multimodal Traveler Information (IMTI), which provides information about more than one mode of travel within a particular information service, they classified these barriers of traveler information:

(1) Lack of the types of information
(2) Lack of awareness of their current use of information
(3) Perception that accessing information is difficult and time consuming
(4) Lack of awareness of information sources (pp.10-11)

Their research also suggested increasing awareness of travel options with comfort and convenience to accessing and comparing, since travel information performs two primary roles. These include an informative role, informing the user about the journey under inquiry while also informing the user that alternatives exist before providing information about them. The second is a challenging role, tackling assumed 'knowledge' and 'truths,' the attitudes toward each mode (Kenyon & Lyons, 2003).

To sum up, the new way of moving, socializing, and sightseeing on road trips conflicts with personal and local experiences while iterative, collaborative, and social travel activities challenge traveler awareness of what is known as knowledge, and what they want and can access as information to build up the link between travel contexts and themselves. Figure 1 illustrates the decision-making process of current observed normal road-trip experience.

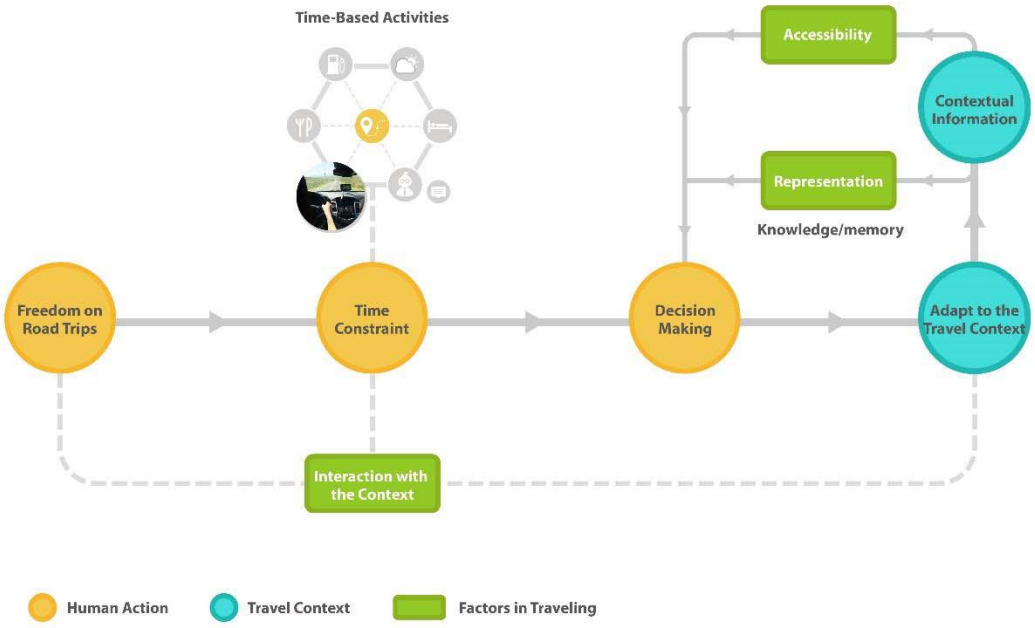


Figure 1. Current Common Decision-Making Process of a Road Trip

2.2 Conceptual Justification

2.2.1 Information Visualization

In accordance with what I discussed above, traditional itineraries with collected information shown by lists are not the only or most efficient way to represent the information of on-the-go road trip. Because the nature of travel planning is not only about receiving intensive data source, but also how to access to instant information contextually, how to organize the information to be visually perceivable and represent it more efficiently as mental support.

With the requirements of adapting to varied changes of context, visual representations show more benefits to help clarify and depict information refined and

simplified while amplifying travel experience intuitively in the domain of UX design. Visualization and UX are essential aids to human cognitive tasks and are valued to the extent that they provide stable and external reference points on which dynamic activities and thought processes may be calibrated and models and theories can be tested and confirmed (Wong et al., 2006).

Information Visualization (InfoVis) is an imperative visual representation approach to interpret, represent, and communicate information. Card et al. (1999) defined InfoVis as the use of computer-supported, interactive, visual representations of abstract data to amplify cognition. Within the current design for travel and travel planning, travel information visualized in maps is the most common and general approach that can help travelers easily find, understand, and assess travel information while making faster and more-effective travel decisions about travel itineraries and places to visit (Sigala, 2012). Moreover, because representation and interaction are noted as two important dimensions of InfoVis (Liu et al., 2008), which increase user acceptance while showing potential values to be applied, the combination of design and technology solves problems for people, and interaction as a vital construction of InfoVis, is being used to link up the using context and user perceptions. Even though InfoVis is a rapidly developing field with multiple-layered data visualized efficiently and intuitively via imagery, icons, text, and connections illustrated through visualization, desired information can be understood more efficiently contributing to road trip experience rather than through a more traditional presentation.

2.2.2 Situation Awareness

Additionally, when it comes to adjustability and flexibility, which offer more possibilities for users to adapt to changing conditions, especially in the domain of interaction design, Endsley (1995) brought up the concept of situation awareness (SA) to support users and reduce human error in interaction processes, which is related to the perception and comprehension of the information of systems. Specifically, for travel experience Cai & Yu (2014) addressed that in an event-driven collaborative system. Awareness refers to the human consciousness about events and their relevance to ongoing or future human activities (Cai & Yu, 2014), which greatly affects people's travel experiences. Similarly, Yu & Chang (2013) discussed that SA captures users' contextual information, such as location and time, needs and interests, and social interactions, which has increasingly become a desire to enhance personalization in mobile travel planning.

In the context of user interface (UI) design, there is also a connection between the presented information and SA, which may also influence a user's acceptance, because to some extent user SA needs require flexibility and reconfiguration (Weyers, 2010). Given that flexibility can provide significant benefits to increase user acceptance (Hollnagel, 1998) and that SA should be taken as an essential part to construct effective UI design, it is assumed that the ability to adapt and adjust the interface to individual needs will support human performance and increase user satisfaction. Meanwhile, it is also possible to allow users free choice in how to reconfigure the interface (Weyers, 2010); as Endsley (1995) claimed, an effectively designed interface can also help to reduce mental workload.

Although how information is presented can greatly influence SA, the UI design determines how much and how accurately information can be acquired and to what degree it is compatible with user SA needs, which is covered by Weyers et al. (2010). Also, SA impacts the process of decision making itself. Considerable evidence is defined by Weyers et al. (2010) that a person's manner of characterizing a situation will determine the decision process chosen to solve a problem. Based on these considerations, it is assumed that by learning more about SA requirements, more-effective UI designs can be established to support decision making in complex environments. Thus to correspond to designing a better UI and to emphasize a user's SA needs, InfoVis was chosen to apply in my travel-aid system design.

2.2.3 Distributed Cognition

Besides the happening of events and their relevance to ongoing or future human activities (Cai & Yu, 2014), another important factor of a good travel experience is determined by people's distributed cognition (DCog).

Developed by Hutchins, DCog is concerned with how cognitive activity is distributed across internal human minds, external cognitive artifacts, and groups of people and how it is distributed across space and time (Hutchins, 1995; Zhang & Patel, 2006). As Zhang & Patel (2006) conceded and quoted this:

> People's intelligent behavior results from interactions with external cognitive artifacts and with other people, and people's activity in concrete situations are guided, constrained, and to some extent, determined by the physical, cultural, and social contexts in which they are situated. (Clancey, 1997; Suchman, 1987; Zhang & Patel, 2006, pp.1)

With the description of components in DCog as internal and external representations, internal representations are the knowledge and structure in individual minds, and external representations are the knowledge and structure in the external environment (Zhang, 1997; Zhang & Patel, 2006). Moreover, all important information about the environment is processed through perception and abstracted and stored in memory as representations or symbols, while cognition is more of an emergent property of interactions between individual and environment through perception and action (Liu et al., 2008). On the other hand, representational media are located within individuals (e.g., memory, knowledge, skills), within group members (e.g., shared meanings) and in the physical structure (e.g., tools such as social media) (Hollan et al., 2000; Hutchins, 2000; Mansour, 2009).

Correspondingly, when it comes to road trips, the interactions between travelers and contextual environment requires people adapt to the material world by changing their forms of moving, socializing, and seeing. As I discussed above, the on-the-go journey and time-based activities of road trips challenge users' travel behavior and plans to cope with unexpected contextual situations, while deciding specific needs and necessary information, which require assistance to access, present, and further reorganize the distributed cognitive system to make use of a different set of internal and external processes (Hollan et al., 2000).

As for representations, among various applications of theories of DCog, Liu et al. (2008) argued about using DCog as a theoretical framework for InfoVis because representation and interaction are two important dimensions of InfoVis and have received considerable attention in InfoVis research (Liu et al., 2008). It is widely acknowledged that "the purpose of visualization is insight, not pictures. The main goals of this insight

are discovery, decision making, and explanation" (Card et al., 1999; Liu et al., 2008). In terms of contribution to design work, Liu et al. (2008) also believed that DCog provides a more useful framework to address the central issues of representation and interaction, interpretive concepts, and methods needed to analyze the role of InfoVis in complex cognitive tasks, even with limitations in providing prescription and prediction (Liu et al., 2008). Thus I proposed that the combination of using InfoVis with the theoretical support of DCog and improving SA could contribute to a better solution for aiding road trips (Fig. 2).

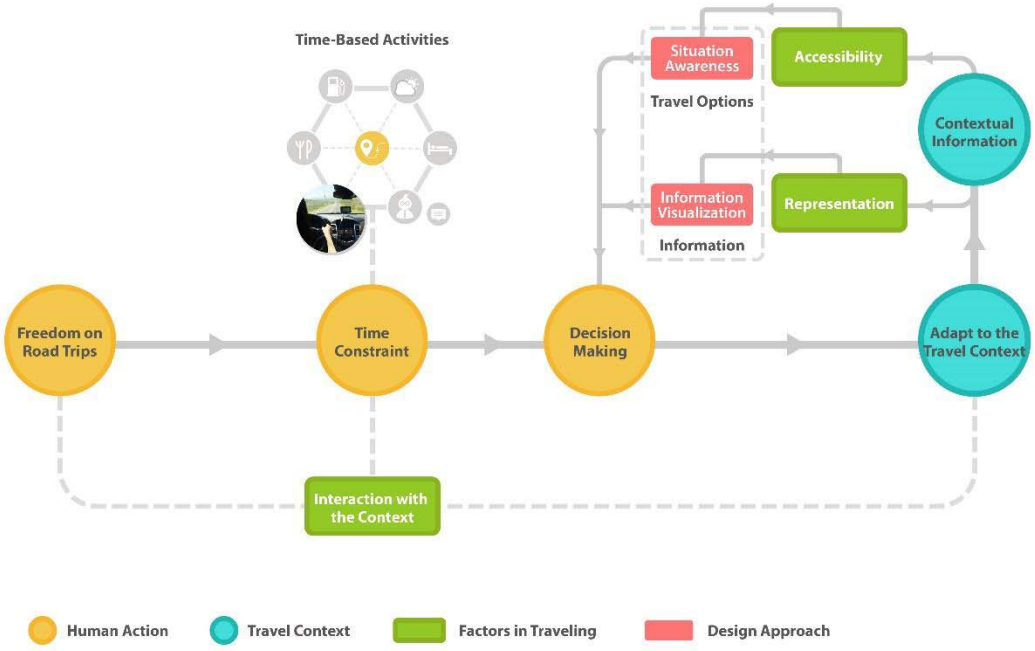


Figure 2. Proposed Decision-Making Process

2.3 Design Approaches

2.3.1 Digital Integration and Proposed Approach

Looking back on travel and its relevant technology, I find that as a global industry tourism thrives on innovation and novelty, and digital tourism, which is not new to travelers, is concerned with the use of digital technologies to support and enhance the tourist experience before, during, and after tourist activity (Benyon et al., 2013). For example, people seem to like managing their flights by using smartphones rather than desktop computers during trips (Liu & Law, 2013). Yet, even with familiar trip planning, Web sites or mobile apps such as *Expedia, TripAdvisor,* and *Tripit,* Benyon et al. (2013) stated that digital or physical supports are a distraction from the experience of engaging in a particular tourist site and reducing the sense of presence (Benyon et al., 2013).

Because of the growing use of mobile technologies, smartphone apps are considered to be the most popular one that can significantly transform the travel experience by changing travel planning; constructing and destructing one's sense of tourism; and reconfiguring the relationships among tourists, places, and others (Wang et al., 2013). In 2013 Wang conducted interviews to understand the impact of smartphone use on travel experiences, presenting that smartphones provide easy access, computational capability, and connection to the Internet while granting travelers the ubiquitous accessibility to plan their trips by using their work breaks, lunch breaks, and the time for commuting. Besides the easier access to information anytime and (almost) anywhere with potential assistance, it shows that applications can change travelers' behavior and emotional states by addressing a wide range of instant information, solving

problems efficiently, sharing their experiences, and storing memories (Wang et al., 2012; Liu & Law, 2013).

It is important to note that during travel, the increased capabilities of smartphones can also support not only basic travel activities, such as planning, reservation, and navigation, adaptively using functions of location awareness or GPS apps to find directions while understanding geographic environments for safety (Wang et al., 2012). They can also use many "micromoments" within the travel process distributed with other multifunctional apps to create spontaneous deviations such as the changes of travel route, duration, and walking distance; finding gas stations; estimating waiting time of rides; "seeing" places as they once were; and initiating unplanned activities. These abilities all extend the functionality of smartphones (Hwang, 2010; Wang et al., 2012; Lai, 2013). Furthermore, mobile apps can also be expanded further to construct personalization, to allow users entering personal preferences, specifying broad travel types, selecting from categories of destinations (e.g., beach, country, adventure, whatever), and drawing on a person's previous travel history as travel recommender systems (Resnick & Varian, 1997).

As the representational medium, the screen can be seen as internal representation of the DCog system, and the cognitive activity of information foraging carried out on it is the processes internal to the system (Hollan et al., 2000). Indeed, mobile tourism apps can offer location-based suggestions that correspond to the importance of amplifying travelers' SA needs and supporting travelers' DCog. And the consistent use of this new location-based media emerges as a new form of travel experience because it satisfies a variety of needs and supports a variety of contexts (Lamsfus et al., 2013). As a result, the

use of a smartphone can transform the travel experience by reconfiguring the relationships between traveler, space, and time (Wang & Fesenmeier, 2013) while providing information that best fits user's current situation (Yu & Chang, 2013).

However, there is no denying that mobile technology also has negative impacts on travel experience. For instance, clear expectations of an upcoming experience may destroy the sense of adventure brought by the uncertainties of a trip, or connections with ordinary life (e.g., issues in the workplace) through emails or text messages that break the feeling of "escape" (Wang & Fesenmeier, 2013). Granted, it is also argued that it enriched the travel experience by keeping social activities and continuous and instant communication with family and friends (Wang & Fesenmeier, 2013).

Given these previous findings, I chose to use the integration of mobile app as the medium to present my design. With easier acceptance of the mobile app, the combination of using InfoVis, SA, and DCog on smartphones was the approach (Fig. 3) I adopted to prompt travel experience, and the small-screen platform challenged the representation and visualization of travel information. Ideally, the aid system could focus on solving the issues of basic travel information searching, spontaneous planning, and adjusting contextual suggestions; automatic synchronization; recommendations; offline operations; and others.

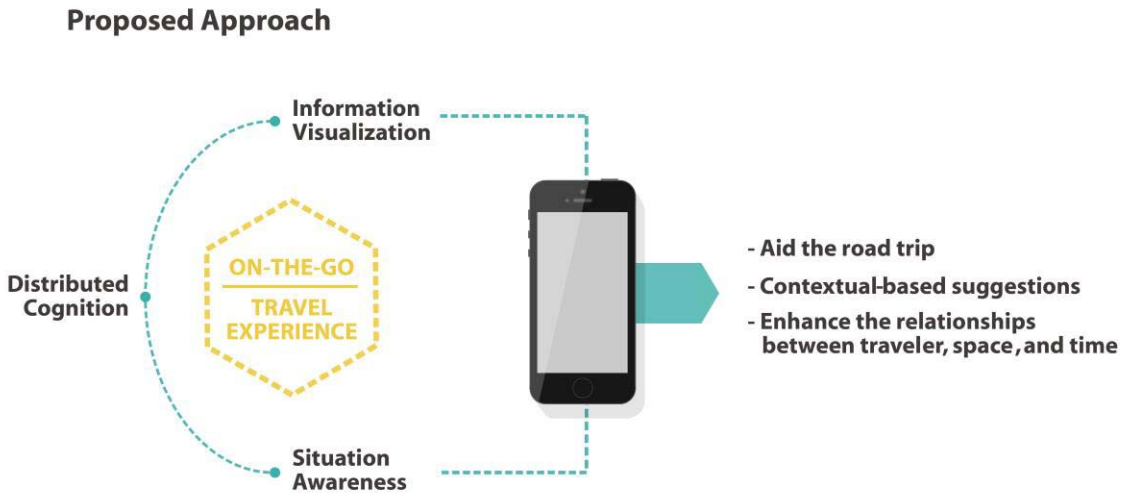


Figure 3. Proposed Approach

2.3.2 Business Perspective

In the book, *Business Model Generation*, Osterwalder & Pigneur (2010) mentioned that a designer's job is to extend the boundaries of thought, to generate new options, and ultimately, to create values for users, and a designer's business involves relentless inquiry into the best possible way to create the new, discover the unexplored, or achieve the functional. Here, in addition to digital integration, I also wanted to explore how business perspectives can contribute to this travel experience design with a smartphone app platform to link up traveler expectations and what services can be offered to attract users.

A business model describes the rationale of how to create, deliver, and capture value; good business model design avoids neglecting the customer perspective (Osterwalder & Pigneur, 2010). As the important component of business model design,

value propositions are seen as the benefits customers can expect from the products and services (Osterwalder et al., 2015). Osterwalder divided value proposition design into two main parts: customer segment and value proposition. The former is described as the tasks users are trying to perform and complete, the problems and risks they are facing, and their expectations of the solution; the latter one is described as the product and services that can relieve the pains to solve the issues. To identify the detailed problems and solutions of the context of road trips, this value proposition view provides a structured synthesis process of customer insights with value creation and delivery.

Meanwhile, defined as value-added factors (e.g., aesthetics) to enhance the value proposition of certain products and services in forming business identity and enhancing the effectiveness of marketing communication (Heide et al., 2007; Strannegård & Strannegård, 2012; Tussyadiah, 2014), the term "design" has been approached in recent business literature in three ways: (1) design as a unique proposition characterizing products and services; (2) design as a state of mind, referring to application of designers' sensibility and methods to problem solving, which makes it a methodology for innovation and enablement (Lockwood, 2010), and (3) design as a process that governs the creation of new products and services (Tussyadiah, 2014). Business literature also defines experience design as the development of experience-centric services (Zomerdijk & Voss, 2010), and service providers can connect to customers in a personal and memorable way through the creation and management of moments of engagements (i.e., service touch points) (Tussyadiah, 2014).

Thus business model design relates to the user-centric mindset of UX design. In terms of adopting customer perspective is a guiding principle for the entire business

model design process, and successful innovation requires a deep understanding of customers, environment, and concerns to gain customer insights and provide solutions concentrating on new findings (Osterwalder & Pigneur, 2010). A preliminary research with interviews and surveys of potential target customers is necessary either to collect or understand their needs; comparing value propositions with existing service products would be practical to innovation. In the following chapter, the methodology framework of conducting this preliminary research will be introduced in detail.

Through integration of design approaches with business strategy, cohesion of the new form of travel experience and the way of enabling new values were enhanced. With this vision, it theoretically set up the relevancy between the challenges of travel, potential design solutions, and issues that could be practically explored further with design research in the context of a road trip.

CHAPTER 3. METHOD

3.1 Framework and Methodology Triangulation

The preliminary research started with an empirical study with my own actual road trip experience to generate travel perspectives on the types of issues that might happen on such a trip and a series of questions that can be used for further interviews. Tussyadiah (2014) describes it as the embodiment of empathic design methods that involves design researchers stepping into the tourists' world by practicing "being a tourist," and also experiencing tourism firsthand to understand its experiences with naturalistic settings beyond their own personal experiences and knowledge (Tussyadiah, 2014). From sections 4.1 to 4.4 in the following chapter, I will introduce the research process that will include timelines from empirical study, International Review Boards (IRB) preparation, potential user interviews and surveys, data analyses, insight syntheses, and problem identification.

Regarding the significance of user experience, which involves a person's behaviors, attitudes, and emotions about using a particular product, system, or service (Hassenzahl & Tractinsky, 2006), it is necessary to identify the current challenges related to travel planning and road trips by reviewing existing design solutions. Also necessary is understanding current market trends through case studies of existing travel planning

systems or smartphone apps. In consideration of features of the travel-aid system I want to develop, interface criticism was chosen to explore the aesthetic aspects of their interface designs as a basis for operational interface evaluation methods (Bertelsen & Pold, 2004). Different from analyses on technical and cognitive aspects, the method of interface criticism takes a cultural and aesthetic level to investigate specific interface designs driven by the travel context. In Chapter 4, section 5, the analyses of 5 travel system designs will be discussed with interface criticism.

In Chapter 5, identified problems of insight syntheses were used to develop the Hierarchical Task Analysis (HTA) for later contribution to the design process, which will be demonstrated with graphical representations. Meanwhile, heuristic evaluation was used to evaluate my design before the final stages of improvement and to serve as guidance in design and implementation. Briefly, the whole process was driven by an iterative design cycle with methodology triangulation, which includes quantitative and qualitative data collection and analysis through interviews and online survey, case studies of existing travel systems, design implementation, evaluation, and redesign.

3.2 The Role of Heuristic Evaluation

Bringing an informal method of usability analysis, heuristic evaluation is done by looking at an interface and trying to efficiently come up with options about good and bad features of the interface under certain rules (Nielsen & Molich, 1990). As an inspection technique, heuristic evaluation gives evaluators significant freedom in how they conduct their work (Nielsen, 1994). Pinelle et al. (2008) also conceded that several studies have suggested that one benefit of using heuristic evaluation is that it helps designers find

important classes of problems not always found with user testing through reviews by other experts. This means that a heuristics evaluation will be helpful and efficient for demonstrating and improving a system's capability.

As discussed in the literature review above, representation and interaction are two important dimensions of InfoVis, but no fully developed theories are sufficient to explain the effectiveness of interactive visual design (Liu et al., 2008). On the basis of the merits of applying heuristic evaluation of doing more investigation and further development of this app design and user experience flow, systematic design principles are needed to guide an evaluation of the visual interface design, potential interaction design, and its work flow with wireframes. I believe a set of design principles can contribute to the process of improvement before delivery of the final design.

CHAPTER 4. PRELIMINARY STUDY ON ROAD TRIPS AND EXISTING DESIGNS

4.1 Field Study as a "Tourist": Understand Tourism Experience

As a designer, empirical study can help to get inspiration and generate ideas through recorded details with natural settings. To come up with more targeted questions to get a better understanding of road trips, I participated in a 7-day road trip with a small group of travelers. It began with searches for travel information, and continued on a frustrating journey with travel by planes and cars, negotiating and rescheduling daily plans. Notes and photos of contextual issues that occurred during the trip were taken for the preparation of a formal interview and an online survey. Figure 4 shows the notes and photos taken on my own road trip. This initial experience contributed to raise the questions of how to effectively access contextual information, how to immediately arrange a new schedule, and how to efficiently gather all contextual information through different apps efficiently. Add to that the need to adjust the schedule of different days, if even possible, without other constraints or conflicts (e.g., the constraint of fully enjoying an attraction and still catching a scheduled flight), among countless needs, obstacles, and other matters.

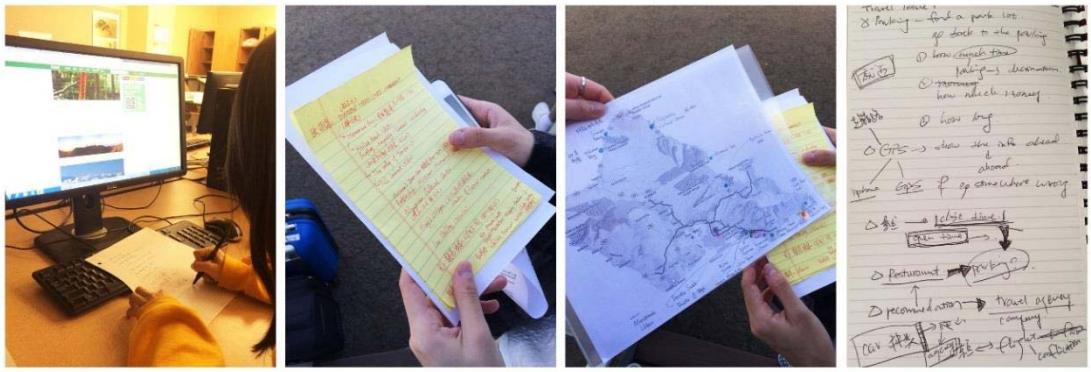


Figure 4. Notes and Photos of the Road Trip Plan

Referring to what Kenyon & Lyons (2003) stated, traveling by car is seen to give freedom and control over individual mobility: over direction, route, departure and arrival times, journey duration, and speed (Kenyon & Lyons, 2003). Traveling by car also offers more possibilities of rescheduling, even with time constraints, according to the initial travel plan. The field study especially reflected that younger travelers, as my group was, might be easily affected by the externalities of contextual environment that will bring on an impulsive change in plans or a spontaneous new decision.

Moreover, information for travel by car is not always actively sought, but passively absorbed from the radio, by roadside sights, or by word unconsciously received not as information, but as knowledge (Kenyon & Lyons, 2003). However, when overwhelmed with fresh contextual information in the trip, the memory of knowledge will gradually fade, which forces travelers to quickly retrieve and access both planned and contextual information. On my own road trip, except for written lists or printed maps my friend and I carried with us to store flight, hotel, and rental car information, I soon realized the need for screenshots or photographs to keep this travel information (Fig. 5),

specifically when there is little connection to the Internet or printed records. And these various external representation records helped to support SA and DCog.

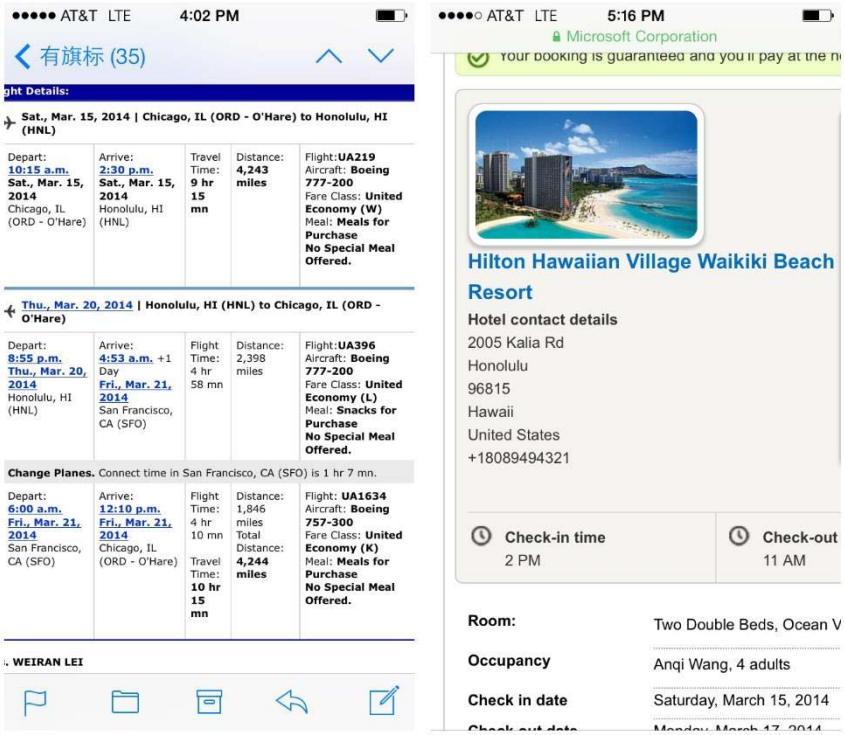


Figure 5. Screenshots of Flight and Hotel Receipts

Based on the findings during this trip, I summarized general and specific issues and developed several questions related to each. They were of great help as I prepared to conduct further interviews and the online survey with potential users to collect more data, especially in regard to the problems they had that could be solved.

4.2 Data Collection: Interviews and Survey

The goal of the interviews and online survey was to better understand and gather public thoughts, concerns, and more detailed information based on diverse experiences of road trips in the United States. To start the interviews and survey, while keeping the

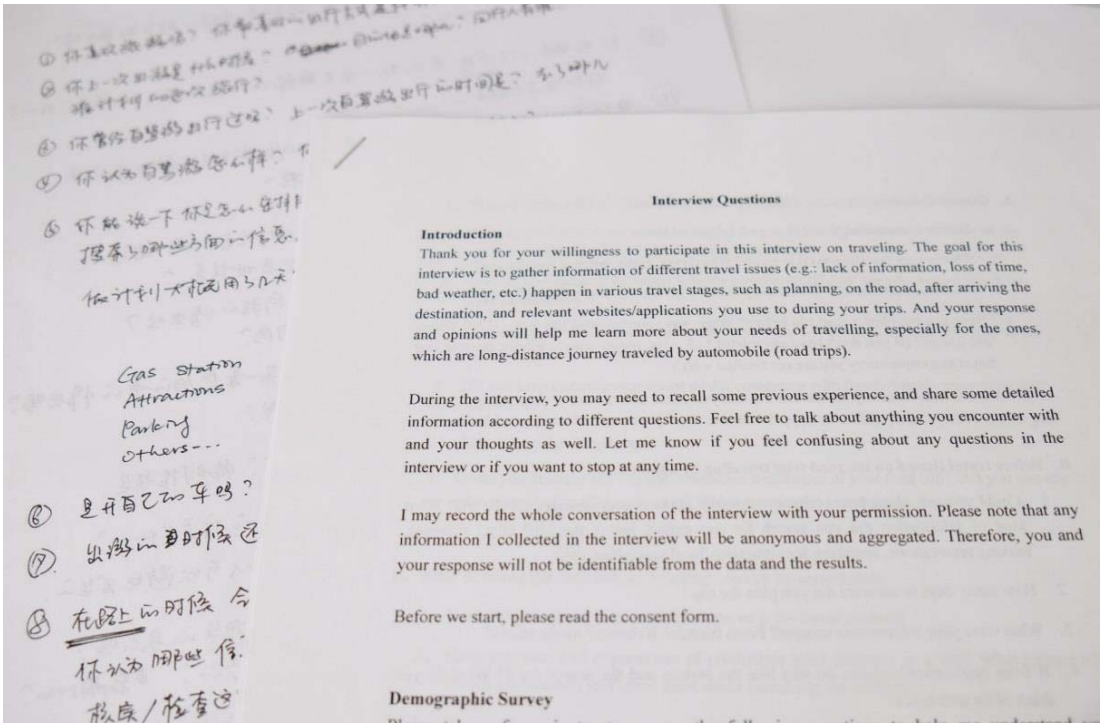
confidentiality of the interviewees when conducting human research, the Institutional Review Boards (IRB) of Purdue University were asked to review a formal evaluation of the detailed research methods, strategy, and questions of the interviews and survey. Following this procedure, the interviews and the survey were approved for human behavior research exemption. A copy of the exempt IRB approval is attached as Appendix A.

Ten subjects were recruited to participate in the interviews over a two-week period, and the duration of each interview ranged from 30 to 45 minutes. The diversity of interviewees could enrich the angles of road trip experience from different occupations, age groups, nationalities, and even the personal experiences of road trips. During the interviews, raw data were recorded through audio recording and later used for transcription and data analyses.

Interview questions started with how different people interpret the meaning of travel in their lives. With this perspective, it can reflect the boundaries of physical and social worlds as the "tourist gaze" connecting to tourism (Urry, 1995), while influencing the interviewee to think of travel experience. The interviewees were then asked to focus on their most recent road trip and to talk about the duration, dates, destination, and brief itinerary of these trips.

For subsequent questions, I divided them (Fig. 6) into four main groups: (1) travel planning, (2) on-the-go journeys, (3) instant or local information, and (4) travel-aid systems to explore more specific issues during their trips with follow-up questions. Along with the interviews, I also took notes (Fig. 7) during the whole process to highlight the important perspectives as focuses or directions in the event of being overwhelmed when

analyzing all the data, which helped me to also generate new questions to follow up quickly.



Interview Questions

Introduction

Thank you for your willingness to participate in this interview on traveling. The goal for this interview is to gather information of different travel issues (e.g.: lack of information, loss of time, bad weather, etc.) happen in various travel stages, such as planning, on the road, after arriving the destination, and relevant websites/applications you use to during your trips. And your response and opinions will help me learn more about your needs of travelling, especially for the ones, which are long-distance journey traveled by automobile (road trips).

During the interview, you may need to recall some previous experience, and share some detailed information according to different questions. Feel free to talk about anything you encounter with and your thoughts as well. Let me know if you feel confusing about any questions in the interview or if you want to stop at any time.

I may record the whole conversation of the interview with your permission. Please note that any information I collected in the interview will be anonymous and aggregated. Therefore, you and your response will not be identifiable from the data and the results.

Before we start, please read the consent form.

Demographic Survey

Figure 6. Interview Questionnaire and Translated Chinese Version

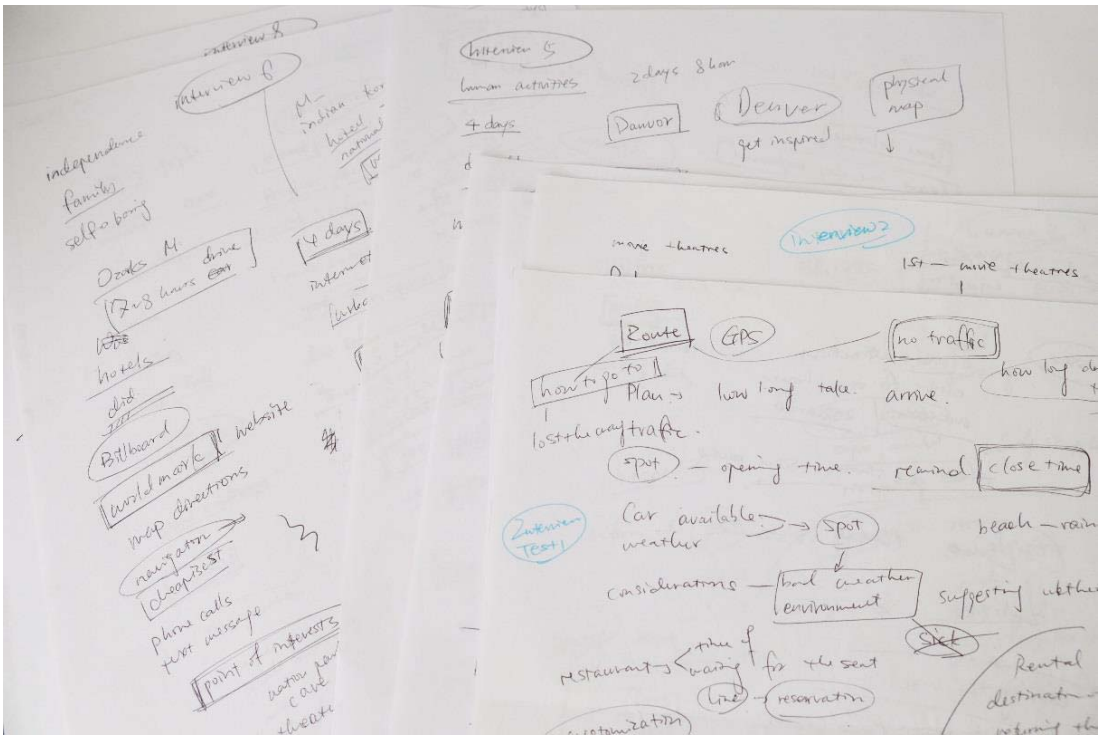


Figure 7. Interview Notes

Apart from the interview, an online survey was conducted through SurveyMonkey (Fig. 8) with similar questions, but it provided multiple choices and open-ended questions that participants could add anything they had encountered. Via the online survey service, the participants could always withdraw the survey at any time, if they wished. However, the difficulty of recruiting participants for the online survey was where to publish the survey in a wide range. Because of the privacy and policy of different travel forums, which were considered as the most ideal channels, it became difficult to spread the link to the survey instead of using personal social media. Fifteen responses were finally collected and stored in SurveyMonkey for export in two weeks.

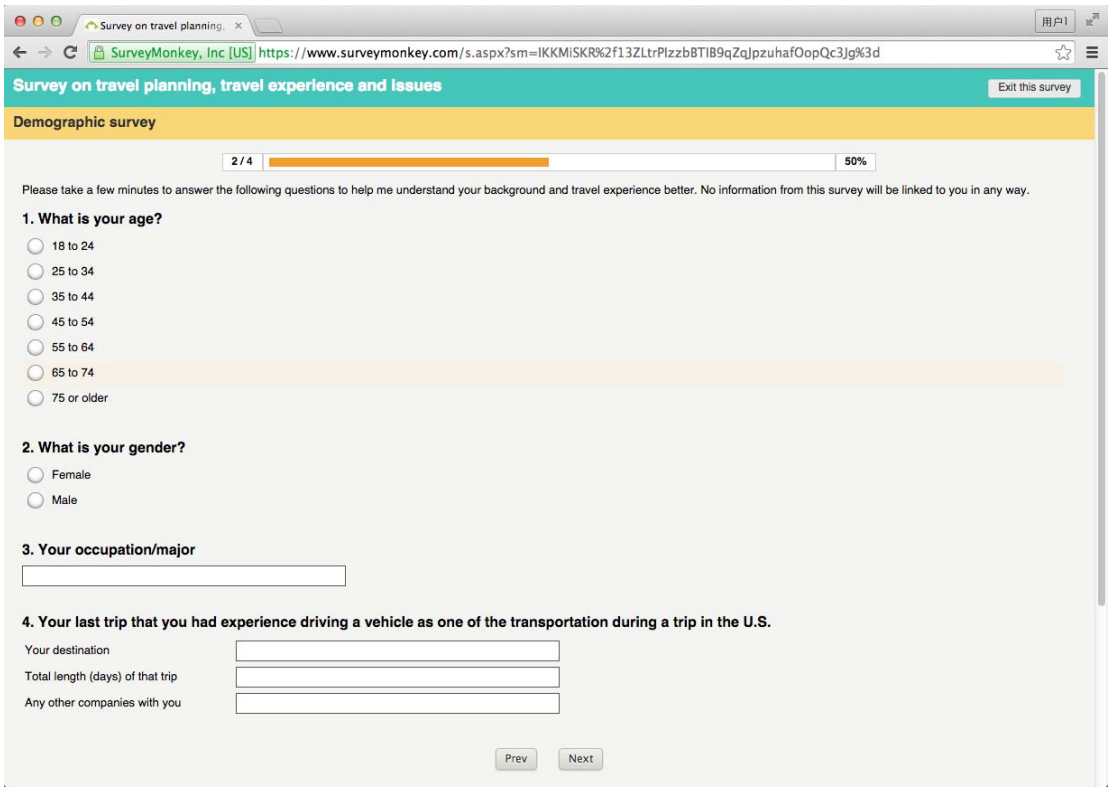


Figure 8. Screenshot of Online Survey, http:// www.surveymonkey.com/s/travelthesis

4.3 Data Analysis and Synthesis

Because data analysis became increasingly inevitable during the procedure of design research to narrow down design directions as I looked for potential innovation insights, categorizing and synthesizing were how I organized the qualitative data of interviews. The screenshot of part of the synthesis notes (Fig. 9) presents horizontal categories, which included time-based code families, main categories, codes, travel issues and problems, traveler expectations, and existing functions or apps corresponding to time-based travel activities of planning, on-the-go journey, instant or local information, and travel-aid systems. These were the main groups of interview questions asked in the interviews.

Time-based code families	Main categories	Codes	Travel issues/pains	Traveler expectations	Existing functions/applications
Meanings of travel		I do like traveling a lot, and I prefer driving over than flying and other means. Because I **see a lot more**. Social and private, the fact we **don't plan too much**.	Moving has different trouble, what I was going to keep and take. Figuring out the rental truck was the biggest part. Talk to people who are experienced.	There is so much to explore, but planning can be difficult and overwhelming. - Roadtripper	**Discovering, Relaxing, and Having fun.**
		The travel means **exploration, experience thing**, seeing new things, getting inspired, get new ideas. I really enjoy it. The opportunity to **get rid if the routine**, **I don't need to follow any time management, just go with the flow**.			
		Because of the **independence**, I like cars. Time to get with the family, travel by myself is boring. **I like travel with people**			
		A chance to meet friend I haven't met for a while. Meeting people and looking at attractions.			
		Travel with family is a lot of fun, **I enjoy the time we are together**, cuz we **don't have the distractions of everyday life**, so you can be together.			
		It's not necessity, but like **a bonus or a life for my life**.			
		The landscape, human activities, American farmers, you see the cities you didn't plan to visit in the half way there.			
		A process to broaden my horison and to see things fun.			
Planning	**Travel info searching**	Attractions (Activities), restaurants, hotels, movie theatres, snack bars(chocolate shops), parks, gas station, parking lot, rental car.	Searched for museums, art museums, and events, but there was nothing going on though. but **didn't plan the detailed activities**.	I can directly decide something, **balance between recommendation and decision.**	Sort places by both type and sub type and distance. Discover places around current location. Search by best in the location/city/nerighnborhood Shown with reviews, rankings, avarage cost, dsitance, direction. Download city guide. Google has ranking for restaurant and hotel. Google maps has similar function as travel plan, pop up ranking, can see the destination in the map.
		Concerts, brew houses, **micro brew house**, their recipes are really unique.			
		We planned vividly on the first day, **general direction**, then speak to people.			
		Rough search starts 1-2 weeks before. 1-2 days before I will search more detailed information.			
		I don't have a certain dead line. It is a casual and fun, relaxing experience, you're looking online about what to eat, where to live.			
		We didn't have anything specific, but we **had some options**.			
		It is **an accumulative progress**, I spend 20 minutes today, and spend another 20 minutes later.			
		Save the places want to go first. Google recommendations and **how people describe it**. Save places that **most people recommend**, especially with the adj such as "recommenda greatly!" "Must to see" "Recommend strongly".			
		Decide the dates, and the schedule is important, it shouldn't be too tight..			
		Companies.			
		Ranking/reviews info: travel tips/blogs/articles written by travellers. Local website, information website, based on people's comments. Giving information of how people felt about. **People's comments**, you can really **rely on** their opinions, **it is true information and feeling about.** So I can deicide what I'm going to do. We use Google.com to find more personal opinions to direct to other websites.	Reviews are competitive.		
			I don't trust review. That's why I prefer to ask local people- **Personality of the recommendation**.		
	Hotel	Price, wifi, how many beds, size of the bed, parking (free), sea view, location, restaurants around, amentities, ratings. Pet friendly, good deal, breakfast, refill the coffees, orange juice. **Mostly is the cost**. I like the **consistency of knowing this one would be good**. How close to the highway.	Different hotels have different coupon, prices, and information.	Free parking, cheap hotel. I want to make my hotel booking separate from the ticket booking.	Access to related services and rank the prices.
			Planned the destination's one before the trip. We don't get hotel until we get into the car. Plan on the road.		
			Didn't plan the hotels before the trip, no rooms occasionally.		
	Attractions	What/where are the attractions.	**Need to research the address even with recommendations.** We didn't have very specific schedule.		
		We are able to look at **attractions around** the places they live.			
		There was a **discount** for the field museum, we roughly chose 2-3 spots. And we had a **rough order**. We started visiting official website, to check the event and discount.			
	Routes planning	Gps can help plan the trip. Figuring out which **path**. The **distance is the biggest factor**, certain states.	How to get there, which city we need to stop at for the distance		Access to map app
	Restaurant	The most **popular cuisine** of the restaurant			
	Clothes	Dress style for restaurant			

Figure 9. Screenshot of Interview Synthesis Notes

With this classification, I synthesized similar issues discussed by different interviewees under the "codes" column as one category of identified problems and later summarized them as traveler "pains" and "expectations." Meanwhile, to guarantee objectivity and authenticity, I used the transcribed descriptions in the interviewees' own

words, rather than my interpretations of them in my words. For instance, they talked about such things as these: “I want to record what I missed.” “I will rank the places and choose the ones I want to visit first.” “Will these places still be open when I get there?” or “Sometimes I don’t know what I want, and I have something randomly showing up.”

Besides transcribing interview recordings, translating from Chinese to English was another process because some interviews were done with Chinese for their convenience and to be sure they understood the specific questions of travel experience.

Although slightly fewer responses were received from the online survey, quantitative data, such as what people most need to search for before a trip, offered the consideration of what kind of information should be present before others in the design (Fig. 10), in other words, information about the points of interest.

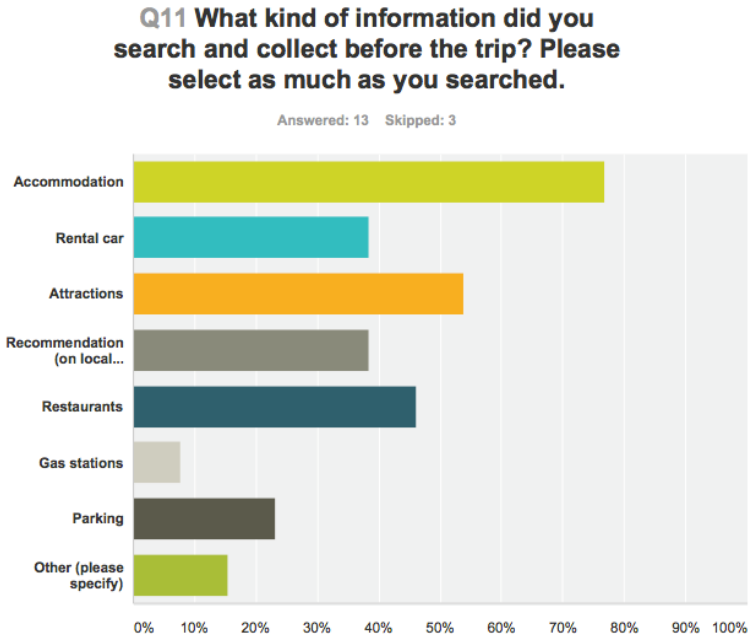


Figure 10. Screenshot of Part of Survey Results

Nevertheless, what I was mostly interested in that the survey revealed is the qualitative description in responses according to the open-ended questions, which were added to the interview synthesis categories, but with a separate document. And here are several selected responses:

> "If it's within 4 hrs driving, I would choose to drive to the destination."
> "I always print out the Google map of the destination and take it with me. I also remind myself to bring a phone charger."
> "We do take notes when asking advice from locals."
> "Time is not enough; have to say next time."
> "We planned each day one night before or that morning by Googling where to visit in…"
> "Can I have some local information from local people; most of the travel is from travelers, which is not the best."
> "It would be better to show the routes that have different personalities, e.g., the best one for sightseeing, the best for musicians…."

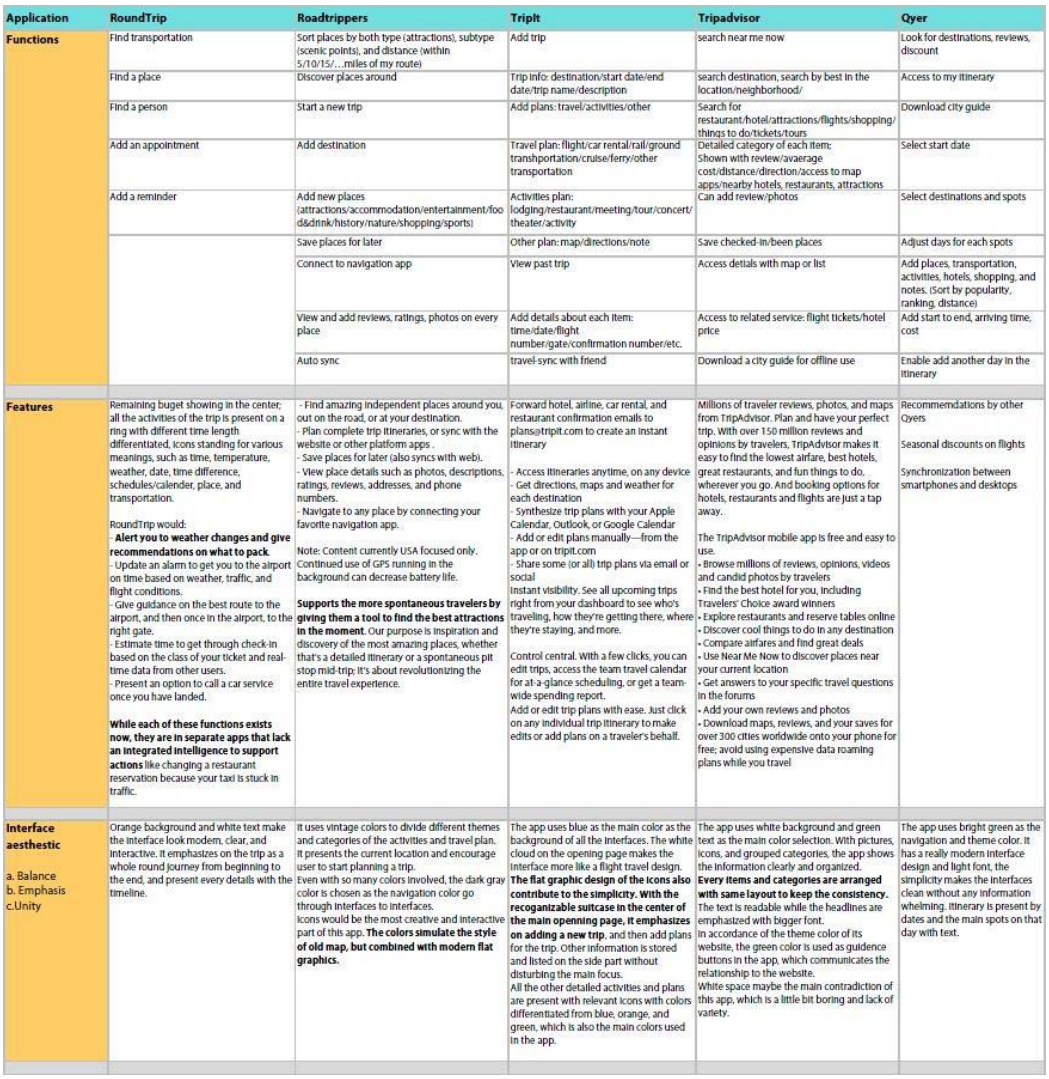
Regarding survey responses, personalization was raised, aside from rescheduling and spontaneous decisions, to suit changing travel situations and needs, because a lack of personalization in context remains to meet the interests, preferences, memberships, and devices of individual tourists, even though there are more and more mobile apps to explore position information for guiding on-the-trip users (Scherp & Boll, 2004; Yu & Chang, 2009).

Based on analyzed findings, I was able to seek potential design opportunities while considering solutions from user points of view as a sense of empathy in the design realm, further defining my design scope. Depending on most demographic features of age, travel patterns, and economic infrastructure, I targeted my user group as young people from 20 to 35 years old who enjoy traveling and are beginning to travel independently, preferring spontaneous planning and diversities in road trips. Before executing a design process, an investigation of existing travel planning systems was

conducted to study the advantages and disadvantages of current design trends while contributing to innovation.

4.4 Case Study of Existing Travel-Planning Systems

Besides the interviews and survey of the targeted user group, study and analyses of existing travel-planning systems allowed me to evaluate their designs by comparing different features and characteristics of current design trends. Five existing designs related to these systems were selected to review: *RoundTrip, Roadtrippers, TripIt, TripAdvisor,* and *Qyer*. As a concept, except for *RoundTrip* as a concept design, all the rest are widely used existing travel planning systems with smartphone apps that are available on the market. Being multifunctional apps, their designs all focus on various integrated functions, such as recommendation, guidance, navigation, and alarm, while presenting creative approaches to categorizing multilayered travel information within travel context. Some of their better graphic designs also enhance user engagement and visual attractiveness. As I introduced the above, interface criticism was applied in this process, and later the data were transferred and organized into a comparison chart. Figure 11 shows part of the results.



Application	RoundTrip	Roadtrippers	TripIt	Tripadvisor	Qyer
Functions	Find transportation	Sort places by both type (attractions), subtype (scenic points), and distance (within 5/10/15/…miles of my route)	Add trip	search near me now	Look for destinations, reviews, discount
	Find a place	Discover places around	Trip info: destination/start date/end date/trip name/description	search destination, search by best in the location/neighborhood/	Access to my itinerary
	Find a person	Start a new trip	Add plans: travel/activities/other	Search for restaurant/hotel/attractions/flights/shopping/ things to do/tickets/tours	Download city guide
	Add an appointment	Add destination	Travel plan: flight/car rental/rail/ground transhportation/cruise/ferry/other transportation	Detailed category of each item; Shown with review/avaerage cost/distance/direction/access to map apps/nearby hotels, restaurants, attractions	Select start date
	Add a reminder	Add new places (attractions/accommodation/entertainment/food&drink/history/nature/shopping/sports)	Activities plan: lodging/restaurant/meeting/tour/concert/ theater/activity	Can add review/photos	Select destinations and spots
		Save places for later	Other plan: map/directions/note	Save checked-in/been places	Adjust days for each spots
		Connect to navigation app	View past trip	Access details with map or list	Add places, transportation, activities, hotels, shopping, and notes. (Sort by popularity, ranking, distance)
		View and add reviews, ratings, photos on every place	Add details about each item: time/date/flight number/gate/confirmation number/etc.	Access to related service: flight tickets/hotel price	Add start to end, arriving time, cost
		Auto sync	travel-sync with friend	Download a city guide for offline use	Enable add another day in the itinerary
Features	Remaining buget showing in the center; all the activities of the trip is present on a ring with different time length differentiated, icons standing for various meanings, such as time, temperature, weather, date, time difference, schedules/calender, place, and transportation. RoundTrip would: - **Alert you to weather changes and give recommendations on what to pack**. - Update an alarm to get you to the airport on time based on weather, traffic, and flight conditions. - Give guidance on the best route to the airport, and then once in the airport, to the right gate. - Estimate time to get through check-in based on the class of your ticket and real-time data from other users. - Present an option to call a car service once you have landed. **While each of these functions exists now, they are in separate apps that lack an integrated intelligence to support actions** like changing a restaurant reservation because your taxi is stuck in traffic.	- Find amazing independent places around you, out on the road, or at your destination. - Plan complete trip itineraries, or sync with the website or other platform apps . - Save places for later (also syncs with web). - View place details such as photos, descriptions, ratings, reviews, addresses, and phone numbers. - Navigate to any place by connecting your favorite navigation app. Note: Content currently USA focused only. Continued use of GPS running in the background can decrease battery life. **Supports the more spontaneous travelers by giving them a tool to find the best attractions in the moment**. Our purpose is inspiration and discovery of the most amazing places, whether that's a detailed itinerary or a spontaneous pit stop mid-trip; it's about revolutionizing the entire travel experience.	Forward hotel, airline, car rental, and restaurant confirmation emails to plans@tripit.com to create an instant itinerary - Access itineraries anytime, on any device - Get directions, maps and weather for each destination - Synthesize trip plans with your Apple Calendar, Outlook, or Google Calendar - Add or edit plans manually—from the app or on tripit.com - Share some (or all) trip plans via email or social Instant visibility. See all upcoming trips right from your dashboard to see who's traveling, how they're getting there, where they're staying, and more. Control central. With a few clicks, you can edit trips, access the team travel calendar for at-a-glance scheduling, or get a team-wide spending report. Add or edit trip plans with ease. Just click on any individual trip itinerary to make edits or add plans on a traveler's behalf.	Millions of traveler reviews, photos, and maps from TripAdvisor. Plan and have your perfect trip. With over 150 million reviews and opinions by travelers, TripAdvisor makes it easy to find the lowest airfare, best hotels, great restaurants, and fun things to do, wherever you go. And booking options for hotels, restaurants and flights are just a tap away. The TripAdvisor mobile app is free and easy to use. • Browse millions of reviews, opinions, videos and candid photos by travelers • Find the best hotel for you, including Travelers' Choice award winners • Explore restaurants and reserve tables online • Discover cool things to do in any destination • Compare airfares and find great deals • Use Near Me Now to discover places near your current location • Get answers to your specific travel questions in the forums • Add your own reviews and photos • Download maps, reviews, and your saves for over 300 cities worldwide onto your phone for free; avoid using expensive data roaming plans while you travel	Recommemdations by other Qyers Seasonal discounts on flights Synchronization between smartphones and desktops
Interface aesthestic a. Balance b. Emphasis c.Unity	Orange background and white text make the interface look modern, clear, and interactive. It emphasizes on the trip as a whole round journey from beginning to the end, and present every details with the timeline.	It uses vintage colors to divide different themes and categories of the activities and travel plan. It presents the current location and encourage user to start planning a trip. Even with so many colors involved, the dark gray color is chosen as the navigation color go through interfaces to interfaces. Icons would be the most creative and interactive part of this app. **The colors simulate the style of old map, but combined with modern flat graphics.**	The app uses blue as the main color as the background of all the interfaces. The white cloud on the opening page makes the interface more like a flight travel design. **The flat graphic design of the icons also contribute to the simplicity. With the recoganizable suitcase in the center of the main openning page, it emphasizes on adding a new trip**, and then add plans for the trip. Other information is stored and listed on the side part without disturbing the main focus. All the other detailed activities and plans are present with relevant icons with colors differentiated from blue, orange, and green, which is also the main colors used in the app.	The app uses white background and green text as the main color selection. With pictures, icons, and grouped categories, the app shows the information clearly and organized. **Every items and categories are arranged with same layout to keep the consistency.** The text is readable while the headlines are emphasized with bigger font. In accordance of the theme color of its website, the green color is used as guidence buttons in the app. which communicates the relationship to the website. White space maybe the main contradiction of this app, which is a little bit boring and lack of variety.	The app uses bright green as the navigation and theme color. It has a really modern interface design and light font, the simplicity makes the interfaces clean without any information whelming. Itinerary is present by dates and the main spots on that day with text.

Figure 11. Screenshot of Existing Travel-Planning System Comparison

Because of different focuses upon traveling, I reviewed each system design with several interface criticism principles: (1) stylistic, (2) standard, (3) materiality, (4) remediation, (5) hybridity, (6) representational style, (7) challenge to user expectations, and (8) development potentials (Bertelsen & Pold, 2004). I also analyzed and evaluated the interface aesthetics with balance, emphasis, and unity as design principles. Here are the individual reviews of each design with their pros and cons.

(a) *RoundTrip*

RoundTrip is a conceptual design that consolidates all disparate pieces of information around a trip and visualizes them as a continuous flow from point of departure to destination and back to the starting point. The entire travel plan is presented with key events (flights, appointments, budgets, among others) that dynamically update as the trip progresses (Tannen, 2013). This design also incorporates a range of travel information from weather, traffic, and flight delays as well as available services such as taxi, airline, hotel, and restaurant reservations to deliver the right information at the right time. As the designer addressed:

> This meta-app breaks a trip down into a sequence of tasks from packing, getting to the airport, checking in, waiting (lots of that), and getting to the hotel, and so on. By thoughtfully integrating data points into actionable information, the traveler is informed and assisted at every leg of the journey (Tannen, 2013).

Besides traditional formats such as lists and notifications illustrated in the wireframes (Fig. 12), *RoundTrip* takes visualization into use, while emphasizing on the trip as a whole round-trip journey from beginning to end to convey a continuous flow, and it presents all information details with timelines. I believe it is innovative to offer an overview of the trip briefly based on time sequence. Moreover, as orange and white are selected as the color scheme, the combination makes the interface look modern and appealing to younger travelers. On the other hand, with a small amount of interface design, it is hard to review its information accessibility and other visual representation.

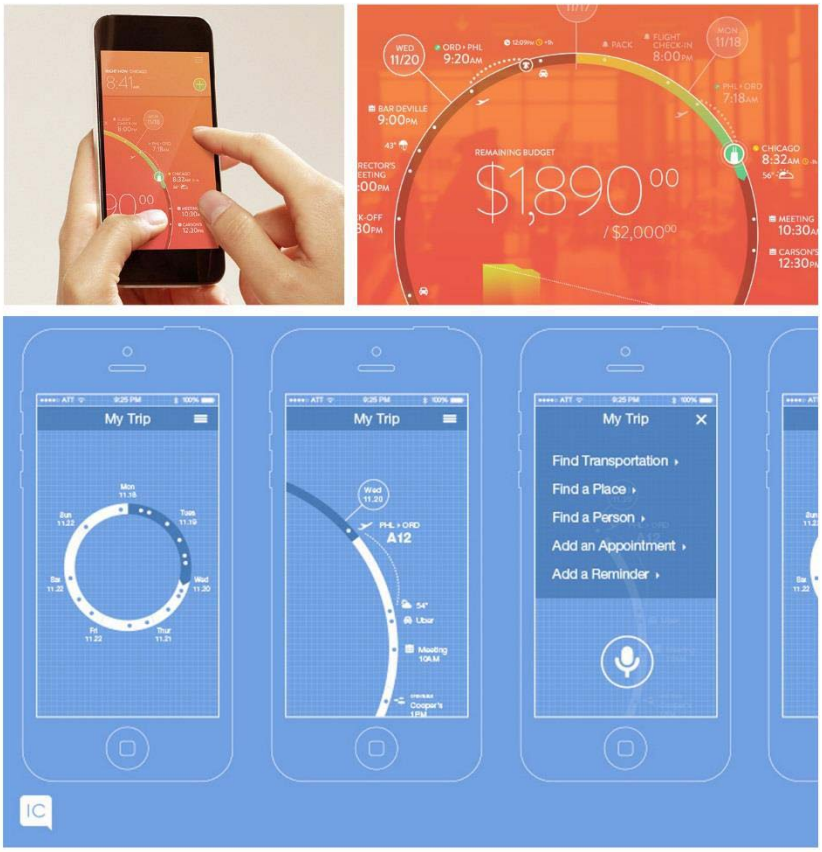


Figure 12. UI Designs and Wireframes of *RoundTrip* (use of images permitted)

(b) *Roadtrippers*

Figure 13 shows the main interfaces of *Roadtrippers*. Two information visualization ways present the overview of one trip: one is the map view, and the other is the list version. Focusing on road trips only, the app includes important information, such as cost of fuel, distance, and length of driving, to increase reliability for users. When discovering places, users can easily add points of interest between stops with the list version, and contextual suggestions will be offered based on either the current location or along the route. Detailed information of stops on the trip is presented with the same layout, organization, and even functions, such as saving, adding to trip, ranking, address,

navigation, official Web site link, and open time. *Roadtrippers* also provides connection to map apps for navigation and notification when completing a task, such as adding a new stop.

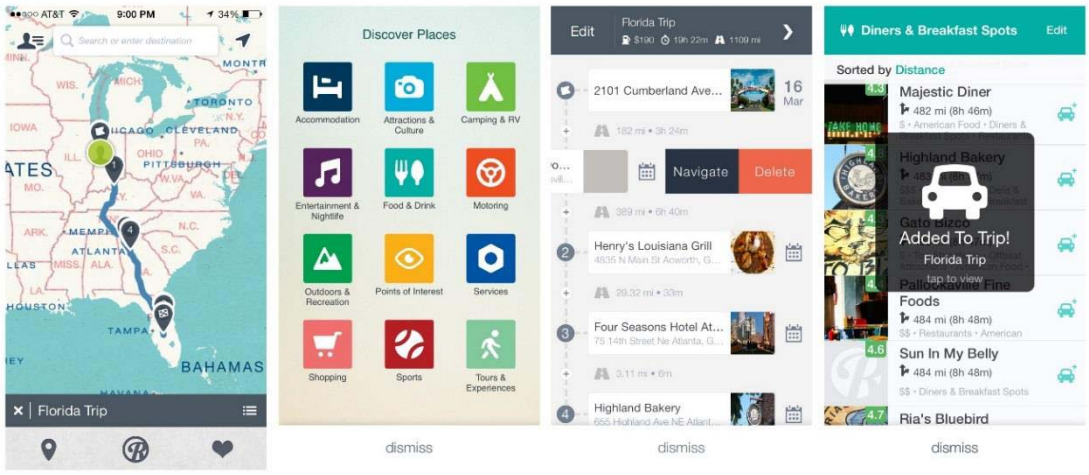


Figure 13. Main Interfaces of *Roadtrippers* (use of images permitted)

The use of vintage colors simulates the style of old maps. Even with various colors involved to categorize different themes of activities and travel plans, gray and dark gray are chosen as the navigation color from interface to interface. Modern flat graphics and thumbnail photos contribute to a metaphorical visual experience.

As the mobile version of the Web site *Roadtrippers*, most functions in the app are easy to use while showing good learnability. However, sometimes too many steps are required to complete one task or to access travel information efficiently, and the map representation seems to be a big challenge to read when too many places or stops are added in a trip because of overlapping.

(c) *TripIt* - Travel Organizer – FREE

Compared with the two designs above, *TripIt* presents a new visual representation style inspired by flight ticketing. With a recognizable suitcase in the center of the main opening page, it puts emphasis on adding a new trip and then adds plans for the trip. The metaphorical icons (e.g., suitcase, plane, and pencil) and layout in the app associated to a boarding pass with flat graphic design also contribute to simplicity.

Moreover, detailed dates, times, and gate numbers are shown with similar fonts used on a flight ticket, which contribute to a user's reflection and cognition of journey and traveling. Specifically, time difference and time length of the flight are also calculated automatically. Such a strategy helps travelers to organize their plans instead of searching for different information while on a trip.

All the sublayered activity details and plans are presented with relevant icons and colors differentiated from blue, orange, and green, which corresponds to the main colors used in the app. Other information such as past trips and "my account" is stored and listed on the left side of the interface without disturbing a user's main focus.

The symbolism representational style is much easier for users to understand and to follow the app's workflow. Users can access past journeys and the current trip by swiping the interface, or they can review the trip through an overview list or stored time information with location awareness supported. Yet there is some contradiction on the colors between the app's icon and its interfaces, since the icon is constructed by orange color (images or background) and text, rather than relevant colors and graphics in the app. And the pull-down menu, which is widely applied in the app, doesn't benefit the efficiency.

(d) *TripAdvisor*

As a well-known travel service, *TripAdvisor* keeps its app a similar color theme of white and green, and it functions as its Web site version. In accordance with the theme color of its Web site, green is used on guidance buttons in the app, which communicates the relationship and consistency to the site. The app also contains different representational styles, such as images, text, and analogical representation, and the combination of photos of scene, text description, and symbolic icons better communicates details of travel context. The multiple functions of the app provide users more opportunities to look for what they want, while literature reviews offer personal perspectives for other users to take advantage of or make their own decisions. Furthermore, *TripAdvisor* has a switch to access either lists or maps when searching for different "things to do."

Without any hidden buttons on the interfaces, access to different categories is easy, and the navigation back and forth is quite clear and easy, but one challenge of the app exists on the layers of hierarchical level, which requires too many clicks and selections to get what users want. Comparing with the two apps discussed earlier, *TripAdvisor* provides too much travel information without synthesis or better accessibility in a travel-planning search.

(e) *Qyer*

Qyer is a newly developed Chinese travel service as the mobile version of its Web site qyer.com. The app simulates the style and theme color of the Web site. With a modern interface design and light fonts, it uses bright green as the navigation and theme color, while the simplicity contributes to clean interfaces without too much information.

One of *Qyer*'s features is selecting the start date of a trip directly from a calendar, which is more interesting and interactive in accordance to the people's daily behavior. Later, a planned itinerary will be presented by list view and map view with specific dates and main stops on one day. However, compared with its Web version, the app omits the function of adjusting the itinerary or stops automatically with smart adjustment, which is used to help organize the plan better according to the locations of different stops. It is quite hard to add transportation or hotels between stops because it allows only adjusting orders under similar categories, which is inconvenient.

In summary, after conducting interface criticisms and comparing different features of this 5 travel service apps, I concluded that the current systems do have their merits on innovative information visualization, graphic design, symbolism representation, and information capacity. Yet most lack adjustability to adapt the changing travel context. The interactions between system and user are quite complex and even confused with too many operations being activated by pressing icons or buttons rather than applying potential and intuitive affordance for interaction. Indeed, it is also obvious to see that even with information visualization applied in these designs, most are still using “list” to present travel information. Their inefficiency to access contextual information indicates that users’ situation awareness and distributed cognition issues still remain. Thus there is a need to thoroughly solve SA and DCog for road trips, thereby enhancing travel experience.

4.5 Problem Identification

4.5.1 Insights and User Needs

In accordance with analysis and synthesis sessions of interview notes, transcripts, and survey results, as shown in Fig. 14, user insights were identified and color-coded into general issues, specific user needs, and existing solutions as several clusters under the timeline of a road trip, which was defined as time-based travel categories in this session, to develop the new travel-aid system especially for road trips. Through the transcription of potential users' issues with their own words, it made the grouping process easier because of specific but similar wording. In the meantime, relevant existing solutions, either in general, of necessity, or particular, were also grouped with the insights.

Figure 14. Post-it Problem Synthesis

After insight categorization under time-based activities, considering a generation of potential design directions and selection of main focuses while following value proposition design principles, identified problems were again synthesized according to a

value proposition design canvas (Fig. 15), dividing into the tasks travelers need to complete in a trip, issues and risks they need to solve, and their expectations of how to solve the issues, further transferring to the values of the new system.

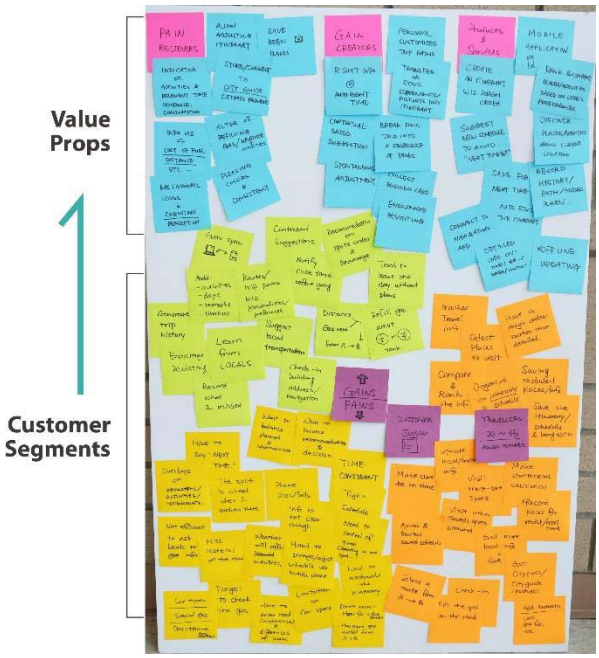


Figure 15. Value Proposition Design

Through grouping and transferring the insights into value proposition, the general categories of information that travelers need to access and compare is planning information, on-the-go information, instant and local information, and contextual-based suggestions related to preferences or interests. Corresponding to the target group of travelers from 20 to 35 years old, the essential goal of the system will focus on travel planning and reconstructing with the following: (1) generate rough order for editing; (2) suggest new schedule based on contextual information; (3) visualizations of itinerary; (4) synchronize screenshots, photos, and e-mails; (5) allow itinerary adjustment on the way; (6) save and share past itineraries or travel locations; (7) travel history archives; (8) local

recommendation; (9) contextual reminders; (10) offline operation and updates. These would meet the requirements of spontaneous planning and reconfiguring a new plan in a road trip more sufficiently and with easier acceptance. Furthermore, the intuitive visualization was the focus of the whole system design.

To explore and organize touch points in the system to benefit road trips and travel experience, I developed a user experience blueprint with travel sequence to understand the relationship among traveler goals, their physical evidence, and interaction with a smartphone.

4.5.2 UX Blueprint

With the belief of incorporating with a user experience perspective, the identified problem categories and user tasks were structurally organized and translated into physical evidence (i.e., physical objects in the trip), customer actions (i.e., activities in the trip), linking to the touch points of items in an app (i.e., interaction with the smartphone) (Fig. 16). During this phase, synthesized findings, insights, and values were recontextualized into a travel experience scenario to correspond with time sequence and context of travel, which shape traveler behaviors, to represent their interrelationship.

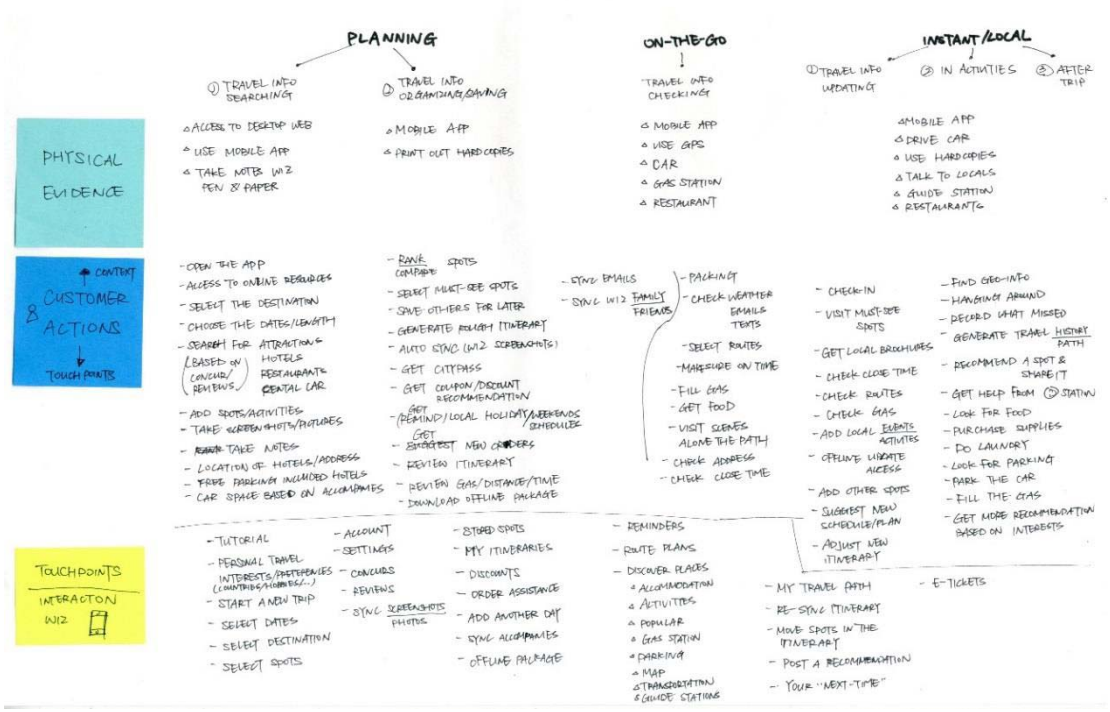


Figure 16. UX Blueprint

I found a translation process of realizing user desires with another ‘language’ in designing. In reference to the design implementation process requiring hierarchical task analysis (HTA) to enhance the validity of the system structure, to start with, the UX blueprint reflects user needs divided by diverse travel stages. The 10 identified problems were then described as correlated steps when interacting with the smartphone, and later clustered into main functions integrating or connecting in the app. To rephrase, with the use of iterative synthesis procedured to build up the structure of the system narratively, its guidance helped to engender design concepts efficiently and targeted. An illustrated version is presented in Fig. 17.

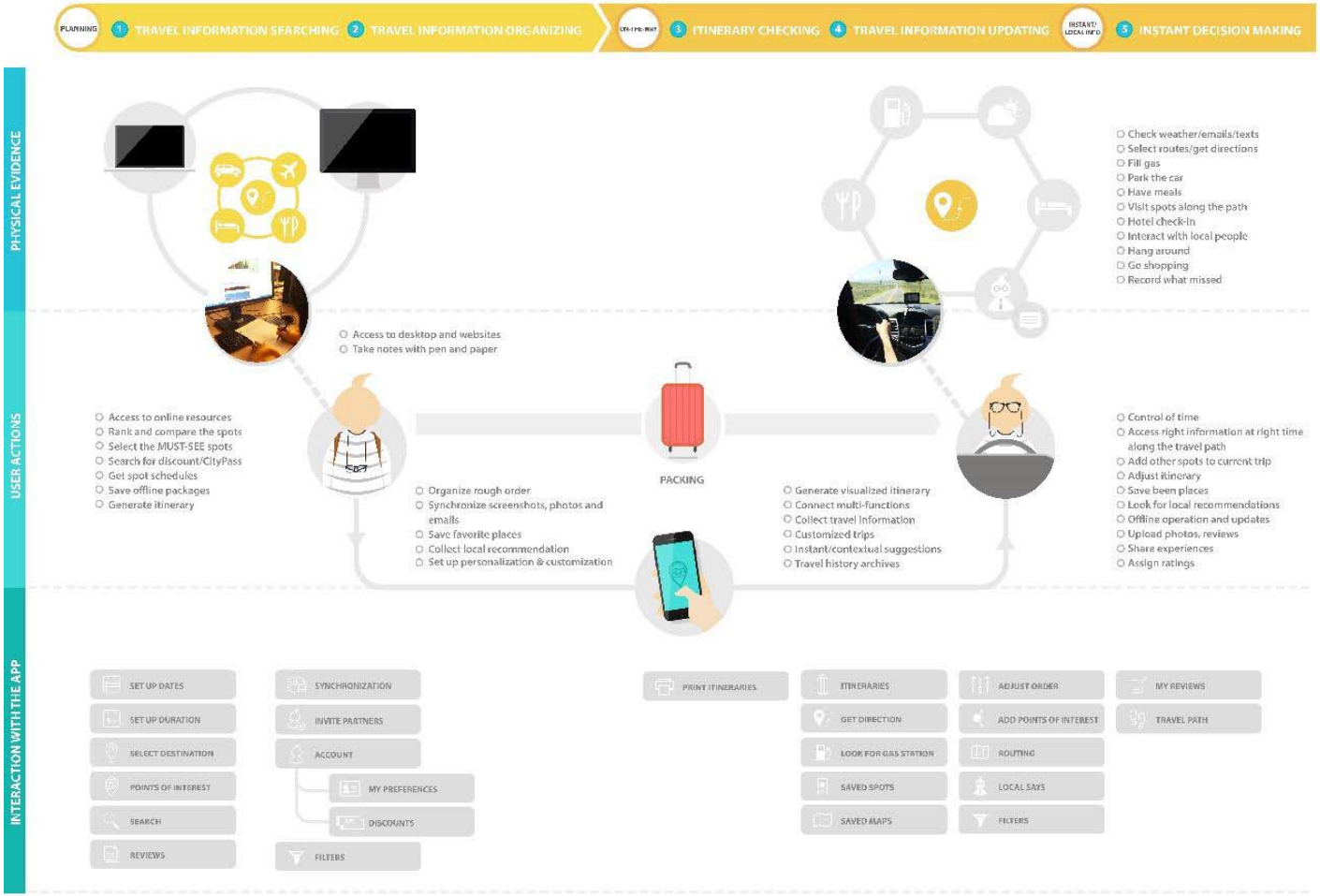


Figure 17. Illustrated UX Blueprint

4.6 Business Model Design and Strategy

Likewise, since the foundation of value propositions has been laid, how to deliver the new value experience packages still needs analysis to design an innovative business model at a strategic level. Integrating to the business design canvas introduced by Osterwalder & Pigneur (2010), general strategy was broken down into partnership, resources, costs, features, value propositions, customer relationships, and delivery channels. However, because of the generic procedures of applying this business model design as a nonprofessional business designer, and in terms of the creativity and innovation responding accordingly to the new design value, another hierarchical business refinement was taken into consideration. It begins with product and service positioning, finance networking, feature enabling, value offering, and on to final delivery and customer experience (Fig. 18).

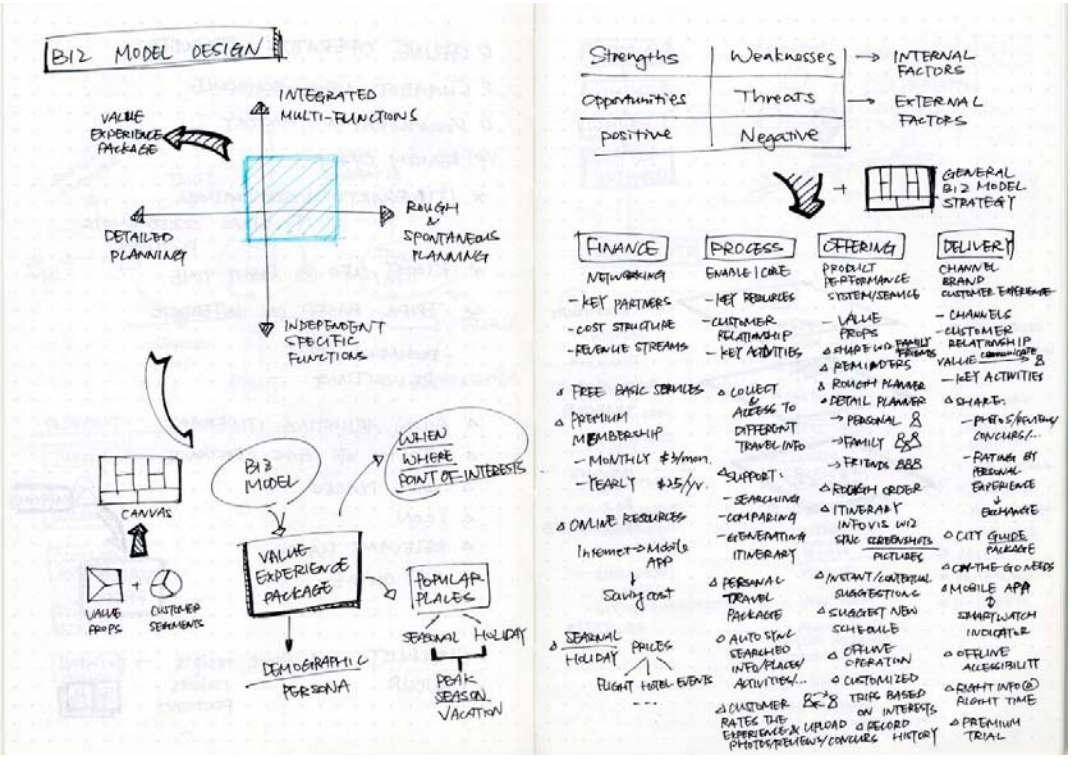


Figure 18. Business Model Design Draft

On the basis of the interface criticism of existing smartphone apps addressed in the previous chapter, I also illustrated the positioning map with the vertical direction presenting the features of the current design trend, and the horizontal direction displaying traveler planning preferences of detailed planning or rough and spontaneous planning to define my service design. I then drafted a business strategy by filling each category with identified but transferred touch points and customer actions of the UX blueprint. As drafted in Fig. 18 in "finance networking," I brainstormed methods and ways of how the app can gain profit with connection to other travel services; in "process," I listed the relationship between the app and users in regard to how people access and treat travel information; in "offering," I highlighted the benefits of using the app as a value experience package, while summarizing the ways of value delivery in "delivery."

In this business model design, along with some general services and new features of visualized itinerary, the synchronization of travel information from e-mails, photos and screenshots, instant and contextual suggestions, local recommendations and personalized suggestions, and monthly and yearly plans are available for travelers to receive more customizable and seasonal discounts and advertisements with more flexibility to switch different value packages over time. From this vision, the business idea is to promote the quality of travel experience by reaching out to a wide range of services that are popular in the market, such as hotel booking, flight booking, CityPass, and discounts of favorite shops or theaters with personalization, while matching travelers' abundant travel patterns and frequency. On the other hand, by encouragement of cocreation via adding partner-editors, ratings, sharing experiences, and uploading photos or review archives, user engagements of the service could be improved and motivated. A brief summary of the

new value experience package is presented in Fig. 19. An illustrated version of business design process is in Fig. 20.

Figure 19. Value Experience Package

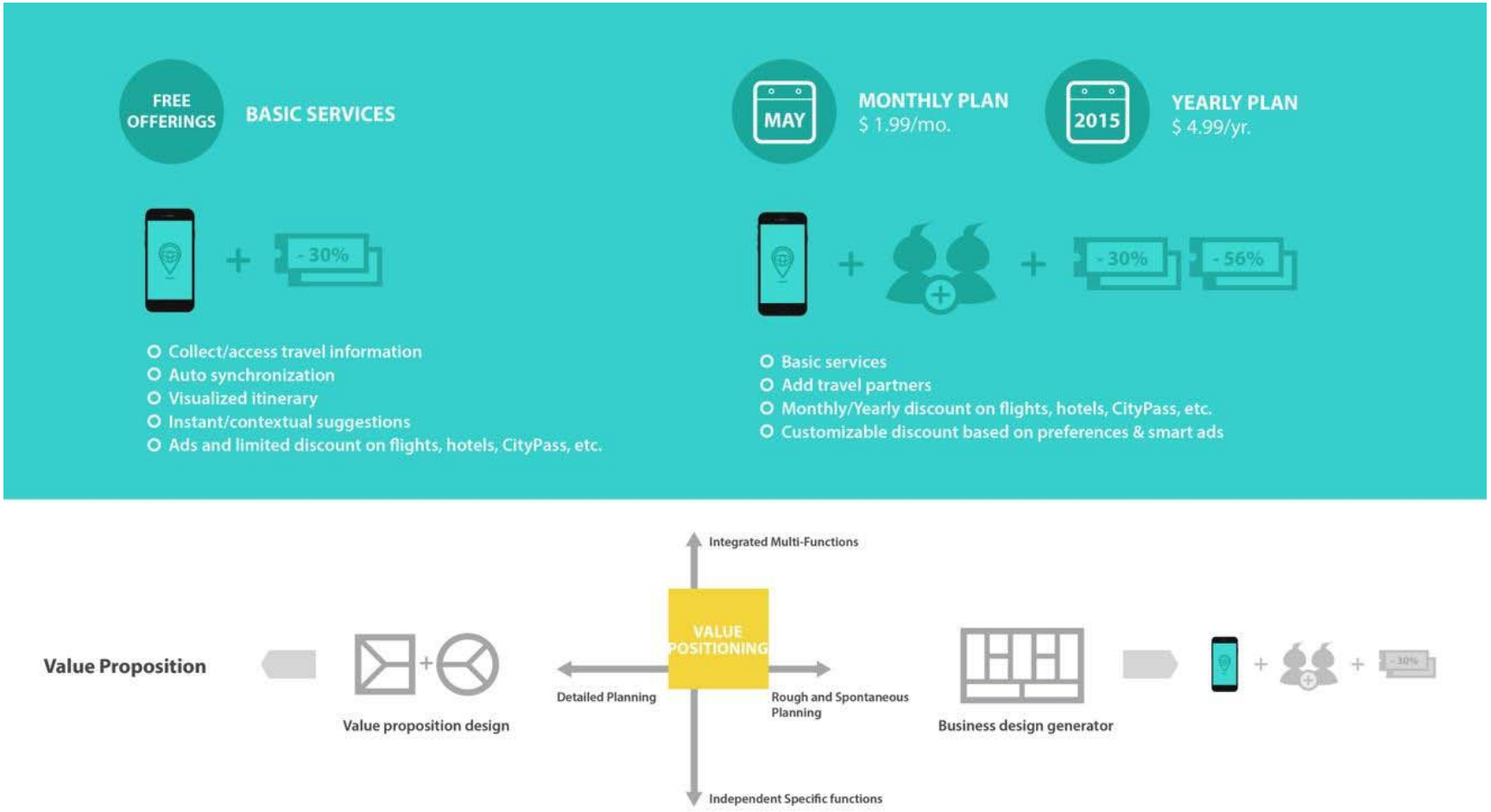


Figure 20. Business Model Design Process and Brief

4.7 Conceptual Framework

In an overview of the process so far, the refinement and exploration of the business strategy not only developed and enriched how my design can add values to the system as a service, but also connected the service with travel patterns to show how the service can enhance traveler experiences, which demonstrated and examined a user-centric mind-set in the interaction design and user experience design world. Moreover, with the highlighted user needs, system specifications, and business values, a draft of a fuller perspective of the experience enhancement skeleton was enabled (Fig. 21).

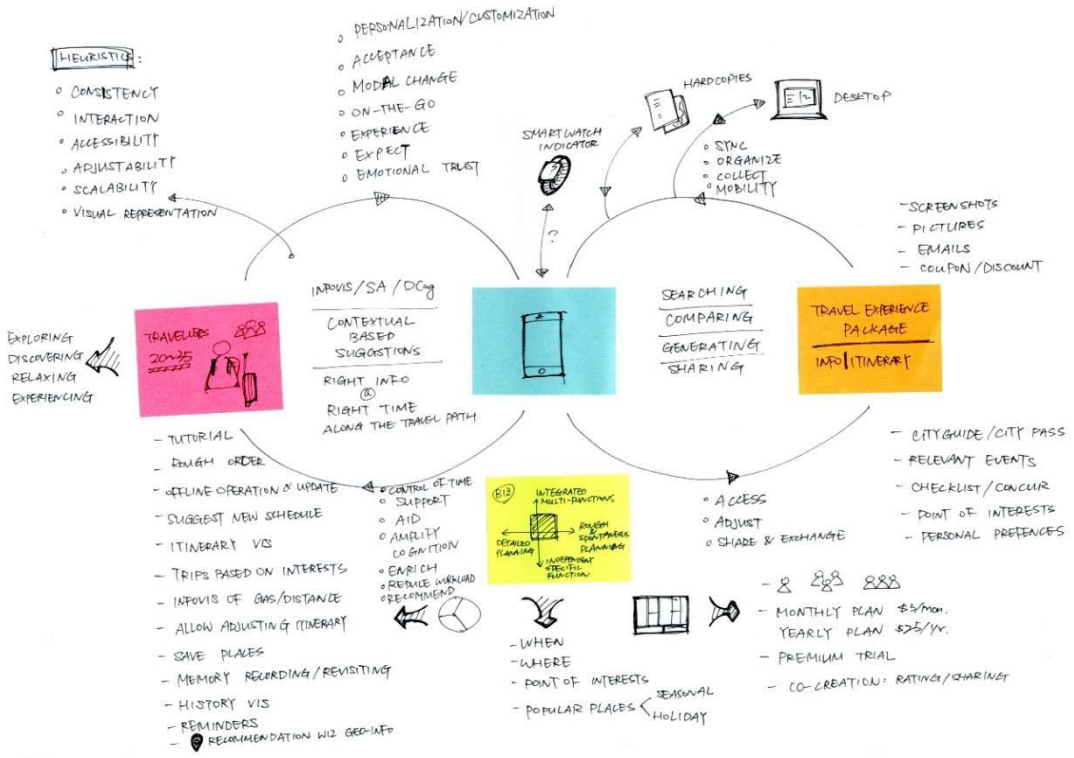


Figure 21. Conceptual Framework Draft

Given the proposed approach of improving travel experience, I was inspired by the skeleton of the new experience to retrieve the connection between traveler and

context with the app, which led me to seek fresh and innovative design directions. When stepping from this fuller picture, I could explore affiliated but subordinate possibilities to optimize the innovation and richness of the system. To be specific, in consideration of the must-have physical items people bring along besides their smartphones when traveling (discovered during the interview session), the portability, wearable properties, and easy accessibility were mostly discussed. And this possibility led to the consideration of synchronizing and connecting to a smart-watch indicator as a supplement device. Furthermore, the drafted framework also helped to summarize potential design principles that could be applied in the later evaluation phase. At last I had built up a complete conceptual framework as a refined version of the draft illustrated in Fig. 22.

Consequently, the visualized framework not only communicates the vital transmission from travel information resources to travelers, but also associates with technological functionalities. Furthermore, being the scaffolds of the design implementation, the conceptual framework addresses the “key words” of continuing the design process, which will be discussed and visually presented in Chapter 5 with a more fundamental and memorable social justification to reduce uncertainty.

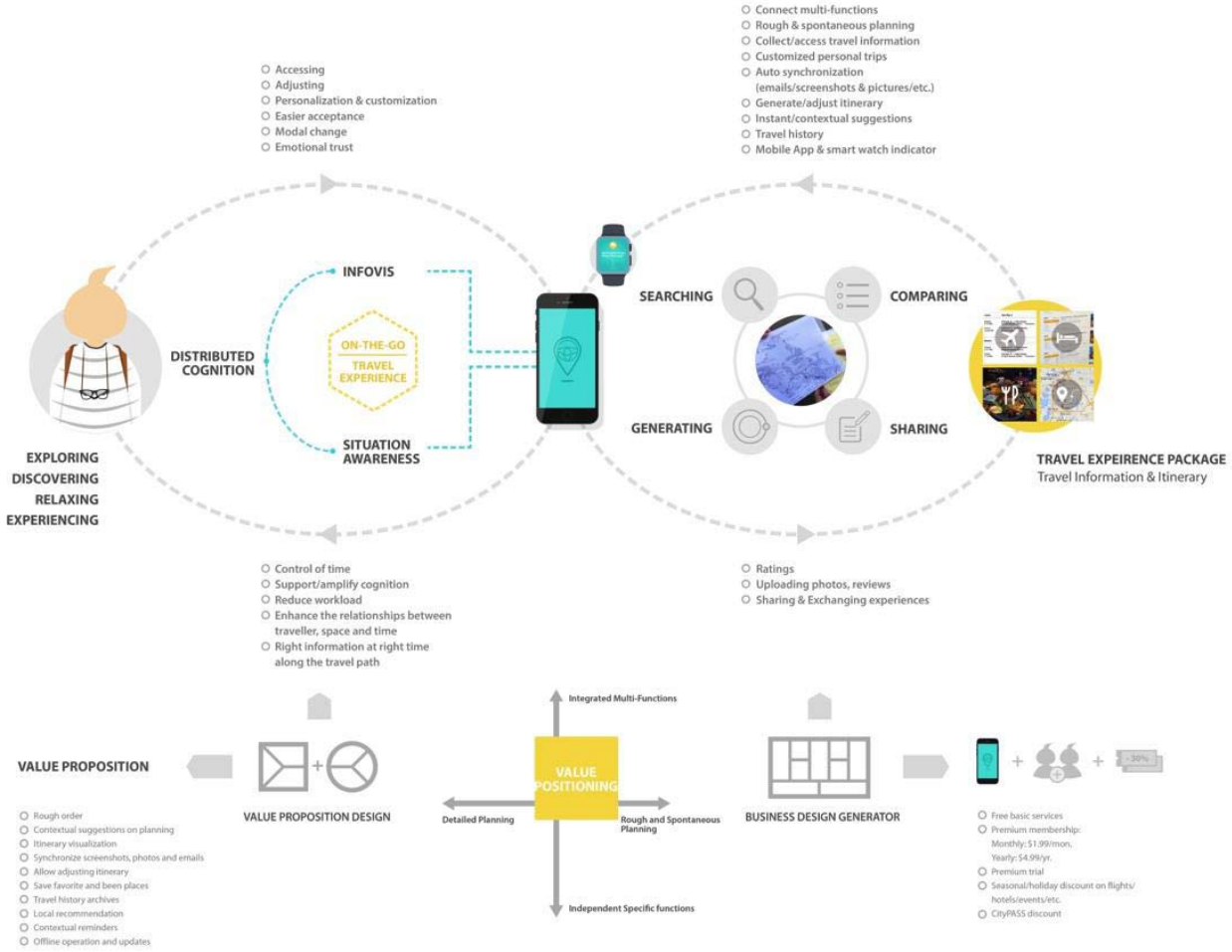


Figure 22. Detailed Conceptual Framework

CHAPTER 5. DESIGN AND IMPLEMENTATION

5.1 Design Requirements

Having benefited from the conceptual framework and availability of synthesized data, I find that the objectives of design requirements for developing the app, while supporting road trips and travel performance, have become clearer and more coherent, responding to functionalities and value propositions.

First and foremost, the information represented in the new design should be readable and adapt to the travel context and user task without being overwhelming or distracting. To suggest a new schedule, relevant information on planning, searching, adjusting, and exploring during a trip should be easily accessed as needed. When it comes to the InfoVis part, the graphic and semiotic icons and elements as visual representations should be easy to understand with consistency and support potential interactivity with affordance to some extent. Particularly, Tussyadiah (2014) deemed that

> …the operational concept of tourism experience should pay attention to interactivity, which includes interactions between tourists and the physical elements of the destinations (i.e., interactions with objects and concepts associated with destinations), interactions with the social elements of the destinations (i.e., interactions with other tourists, locals, tourism employees, and other social networks associated with destinations) and interactions with the mélange of media associated with the destinations (i.e., interactions with mass media, marketing materials, etc.) (Tussyadiah, 2014).

Good usability is also desired as ease of use. Moreover, with emphasis on SA and DCog, the design should help to reduce mental workload by managing the time control offering contextual-based suggestions before or during a trip; multifunctions are connected or built-in.

To integrate with other universal functions and services, such as personalization and points of interest, I again investigated current theoretical opinions. Zhang & Arentze (2013) described points of interest as an important part in geology data and transport data are set up independently where people can check out the opening hours for specific types of facilities. Yu & Chang (2009) had this to say:

> …personalized location-based tour planning recommendation services should be able to integrate information about tourists' preferences, needs and constraints, location and time information, destination and attraction information, as well as recommendation models and rules in order for recommending personalized tour plans in which sightseeing spots, restaurants, and hotels are bundled to match the context and location aware conditions. (Yu & Chang, 2009, pp.39)

And they also believed that collaborative filtering technologies can attract more interest in the travel domain (Kansa & Wilde, 2008). Thus far, the objectives have become more comprehensive to implement designing.

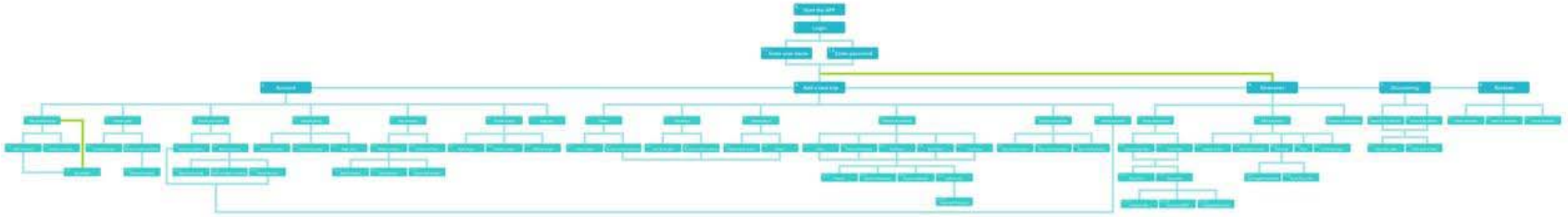


Figure 23. Hierarchical Task Analysis Chart

5.2 HTA and Brainstorming

As I analyzed and simplified in the UX blueprint illustrated in Chapter 4.5.2, the HTA list was created in the role of guiding the wireframing of user interfaces on the basis of functionalities and its relative visual representation on interfaces. Similar to the conceptual framework, HTA reflected the blueprint while summarizing the design requirements as the skeleton of the user experience when using the system. Figure 23 shows the graphic chart, which was created to communicate the corresponsive hierarchical layers intuitively to lead the later user interface flow.

A structured sequence with main touch points described is outlined in the list below:

0. Start the app
1. Log in
   - 1.1 Enter user name
   - 1.2 Enter password
2. Account
   - 2.1 Preferences
     - 2.1.1 Add interests
     - 2.1.2 Delete interests
     - 2.1.3 Access to my profile of interest or preference summary
   - 2.2 Travel Path
     - 2.2.1 View travel history or traveled trips
     - 2.2.2 View photo or review anchors
       - 2.2.2.1 Access to photos or reviews
   - 2.3 My travel partner
     - 2.3.1 Invite a partner
       - 2.3.1.1 Select a trip to share
     - 2.3.2 Add a partner
       - 2.3.2.1 Add through email
       - 2.3.2.2 Add via other contacts
       - 2.3.2.3 Share the trip
   - 2.4 Saved stops for revisiting
     - 2.4.1 Keep the saved stops
     - 2.4.2 Check in at a stop
     - 2.4.3 Delete a place
     - 2.4.4 Map view

- 2.5 My reviews
  - 2.5.1 Write reviews
    - 2.5.1.1 Add location
    - 2.5.1.2 Add photos
    - 2.5.1.3 Share the review
  - 2.5.2 Share a review
- 2.6 Saved maps
  - 2.6.1 Add a map to download
  - 2.6.2 Delete a map
  - 2.6.3 Offline mode
- 2.7 Log out

3. Add a new trip
   - 3.1 Add dates
     - 3.1.1 Select dates
     - 3.1.2 Access to suggested destinations
     - 3.1.3 Access to filters
   - 3.2 Add destination
     - 3.2.1 Select destination
     - 3.2.2 Access to filters
   - 3.3 Add duration
     - 3.3.1 Access to suggested destination
     - 3.3.2 Access to filters
   - 3.4 Add points of interest
     - 3.4.1 Add cities
       - 3.4.1.1 Search cities
       - 3.4.1.2 Switch categories
       - 3.4.1.3 Access to details
       - 3.4.1.4 Add to trip
     - 3.4.2 Add attractions
       - 3.4.2.1 Search attractions
       - 3.4.2.2 Switch categories
       - 3.4.2.3 Access to details
       - 3.4.2.4 Add to trip
     - 3.4.3 Add restaurants
       - 3.4.3.1 Search food log
       - 3.4.3.2 Switch categories
       - 3.4.3.3 Access to details
       - 3.4.3.4 Add to trip
     - 3.4.4 Add activities
       - 3.4.4.1 Search activities
       - 3.4.4.2 Switch categories
       - 3.4.4.3 Access to details
       - 3.4.4.4 Add to trip
     - 3.4.5 Add recommendation from locals
       - 3.4.5.1 Search local says
       - 3.4.5.2 Switch categories

- 3.4.5.3 Access to details
- 3.4.5.4 Add to trip

3.5 Synchronize travel information
- 3.5.1 Synchronize e-mails
- 3.5.2 Take screenshots to synchronize
- 3.5.3 Retrieve photos in album to synchronize

3.6 Invite another partner

3.7 Generate itinerary

4. Itineraries

4.1 View itineraries
- 4.1.1 Upcoming trips
  - 4.1.1.1 Overview of the trip
  - 4.1.1.2 Daily plan
    - 4.1.1.2.1 Instant information
    - 4.1.1.2.2 Access to map app
    - 4.1.1.2.3 Access to suggested actions
      - 4.1.1.2.3.1 Open or close hour notification
      - 4.1.1.2.3.2 Location awareness to preferences or time
- 4.1.2 Past trips
  - 4.1.2.1 Summary of trip information

4.2 Edit itinerary
- 4.2.1 Adjust order
- 4.2.2 Add stop to trip
- 4.2.3 Routing
  - 4.2.3.1 Get suggested order
  - 4.2.3.2 Draw the order
- 4.2.4 Synchronization
- 4.2.5 Print itinerary

4.3 Contextual notification

5. Discovering

5.1 Search by interests
- 5.1.1 View the stop information
- 5.1.2 Add stop to trip

5.2 Search by filters

6. Reviews

6.1 View reviews
- 6.1.1 Add a stop in the review to current trip

6.2 Search reviews

6.3 Access to local reviews

Further, it is stated that every design execution is driven by rapid sketching in the early brainstorming stage. Regarding the presentation of visual and multiple ideas while applying InfoVis as a prioritization of this travel-aid app design, I started a brainstorming

session to put thoughts, interpretation, and inspirations into rough visual sketches (Fig. 24) of visualizing travel itineraries with low fidelity. By doing sketches, I was able to develop design concepts from a wide scope with traditional list representation, innovative visual representation, and even the combination of both. For example, circular representation is focusing on time sequence; abstract geographic representation is mainly used for itinerary overview; and a card representation classifies information categories.

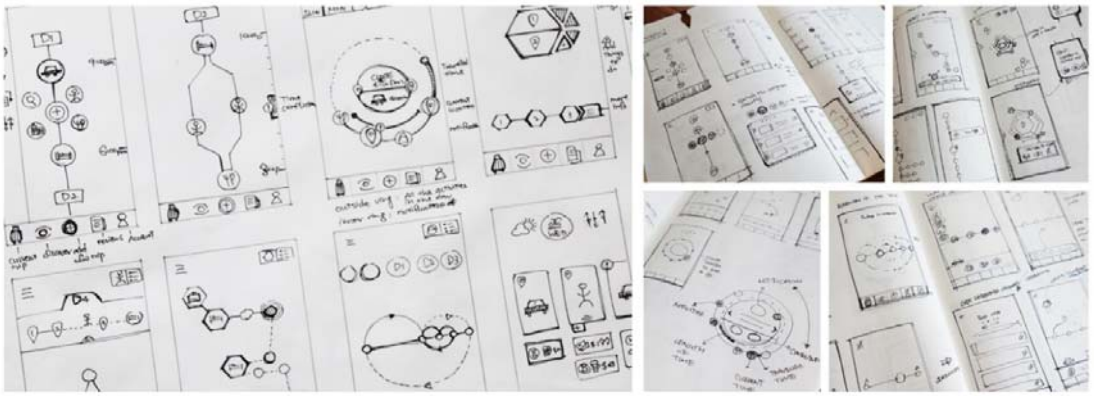


Figure 24. Brainstorming

In total, 10 concepts with different visualization focuses were generated to illustrate variations and possibilities. Because of conceptualizing InfoVis in a travel itinerary with a more creative and unified approach, four of them were selected (Fig. 25) for a second round to develop detailed interface assets to examine feasibility and practicality. Different visualization representations were applied in the four selected ideas. As presented in Fig. 25, from left to right, the first concept applies list representation with graphic icons of every activity and its time; the second concept takes circular representation with two rings being used to present time confliction; the third illustrates the overview connection of a trip; and the fourth concept depicts travel directions between each place.

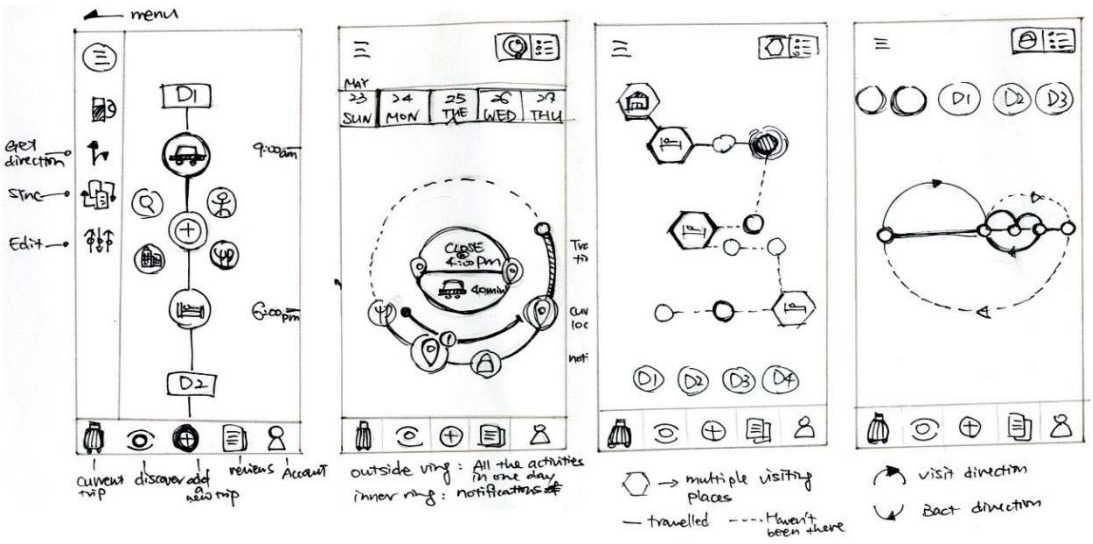


Figure 25. Selected Four Initial Ideas

5.3 Concept Development and Wireframing

When developing the interface assets of visualized itinerary, a time-based sequence was prioritized to address the focus on travel time management. Meanwhile, I tried to illustrate an initial daily plan while presenting the notifications of things happening at the same time within the timeline to formalize SA and support DCog. For instance, the left driving time from place *a* to place *b*, the closest gas station in the same direction of driving, road under construction, time confliction with the open hours, and so on.

With distinctive merits of each representation discussed above, I admit that the list representation of idea A (Fig. 26) is the most general idea to display daily or overview travel information, and the circular representation of idea B (Fig. 27) improves the correlation between on-the-go information and planned itinerary, which provides potential comparison possibilities on time constraints further to improve situation awareness. On the other hand, it is seen to be contain more-abstract metaphors when

idea C (Fig. 28) and idea D (Fig. 29) are applied because of missing information with zooming applied to the whole itinerary. However, these two ideas drew attention to an overview of geographic information, which should be connected as a whole and then split into daily plans. Thus to emphasize the linkage between days and the entire journey, location awareness, and how travelers can compare suggested information with their current situation, I decided to combine the circular prototype of idea B with an overview itinerary structure of idea D to develop and finalize the whole system design.

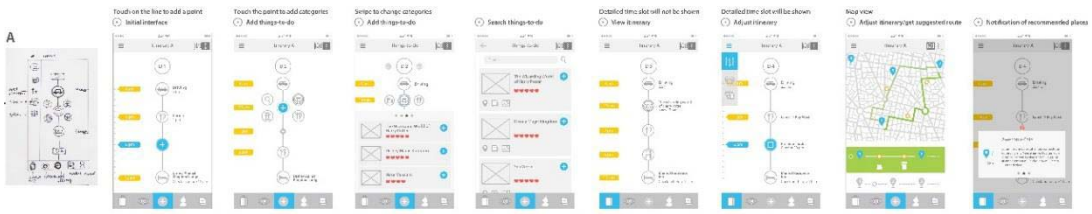


Figure 26. Developed Interface Assets of Idea A

Figure 27. Developed Interface Assets of Idea B

Figure 28. Developed Interface Assets of Idea C

Figure 29. Developed Interface Assets of Idea D

Yet, besides refining the visualization design and arrangement of elements, to develop the final system as a wireframing session was necessary to transfer HTA and touch points, which was conducted earlier, into graphic assets. A first round of wireframing was developed only on the itinerary visualization part and on how to add stops on a trip (Fig. 30). Further, relevant functions were added. These wireframes, shown in Fig. 31 were created and organized by categories of the main function and its icon. The navigation between each interface was then present with pink lines to demonstrate the work flow structurally before demo prototyping. In the wireframing session, only buttons and functioning icons were assigned with colors to maintain simplicity while the navigation was being highlighted.

Figure 30. Wireframing of Itinerary Visualization

Figure 31. Wireframing of the Whole System Structure

5.4 Visual Design and Interaction Design

Approaching the final stage before evaluating the whole system design, I found that visual design and interaction enabled coloring and polishing the visual interfaces with concrete design language. Figure 32 shows the developed icon set arranged by sizes and functions. To keep both universal and unique, several icons were designed for this

new app (i.e., wheel, synchronization between e-mail and plan, luggage, and others), and some were developed with familiar and easy common sense. On the other hand, the color scheme settled on was turquoise, yellow, green, and gray to avoid overwhelming colors.

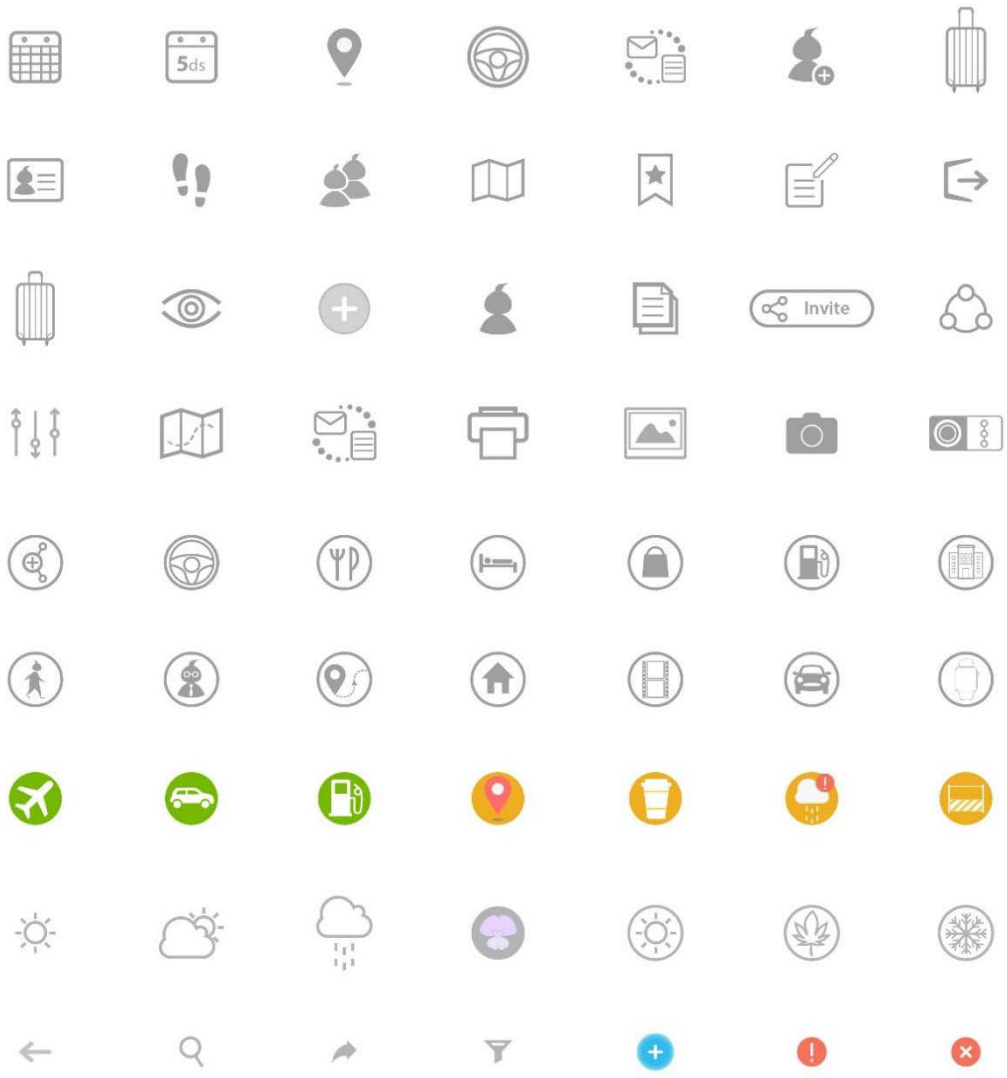


Figure 32. Developed Graphic Icons

Based on the circular prototype, I refined the hierarchy of switching from an overview of a plan to a daily plan. Basically, menus and submenus are more obvious and

relevant to be found upon different interfaces and use contexts, further enhancing the accessibility. In the final visualization design of the itinerary (Fig. 33), two rings surround one badge in each diagram to represent daily plans, contextual information, and notification with time sequence. As time passes, a solid dot that indicates current time will appear with clockwise movement, and suggested actions are available to users with better visibility and less operational steps of pressing or searching to reduce human workload.

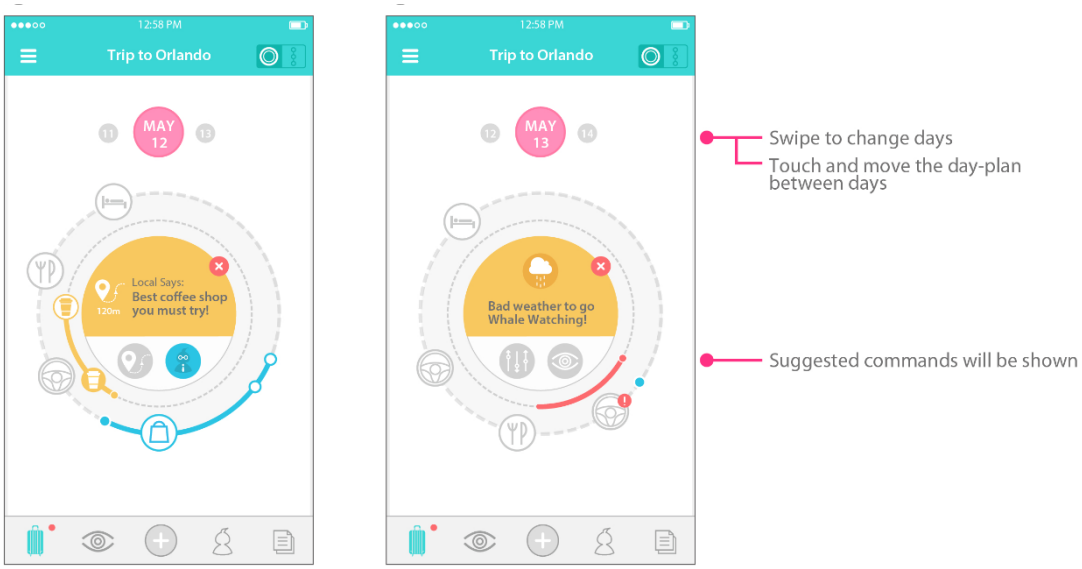


Figure 33. Detailed Daily Plan Interfaces

To develop the interaction part, I took a “thumb zone” discussion as reference (Fig. 34), embedded in the interface layout and construction. In related articles, how people interact with their phones was discussed, and the thumb zone heat map outlines the hard-to-reach areas of the screen when using one hand, referring to “the most comfortable area for touch with one-handed use” (Ghazarian, 2015). In other words, except for interaction with the system, which does affect user experience from the design

perspective, the interaction with a physical smartphone also mutually affects the design. So when exploring how the components displayed on the screen, I ranged the importance of the functions or icons merging with the heat map. Also, subtle interactions, such as swiping the categories of points of interest and pressing for a relatively long time to enable one function or operation, were involved.

Figure 34. One-Handed Thumb Zone Heat Map

After investigating interaction design and assigning primary color schemes to the system, I developed all overlying system interface assets (Fig. 35) on the wireframing. As I discussed earlier, driven by an iterative design cycle, evaluation can serve as guide to design and redesign before delivery of the final design, and there is no doubt that heuristic evaluation is helpful and efficient for demonstrating and improving a system's capability. Therefore in the next chapter I will discuss conducting heuristic evaluations for this project, its results, and redesign process.

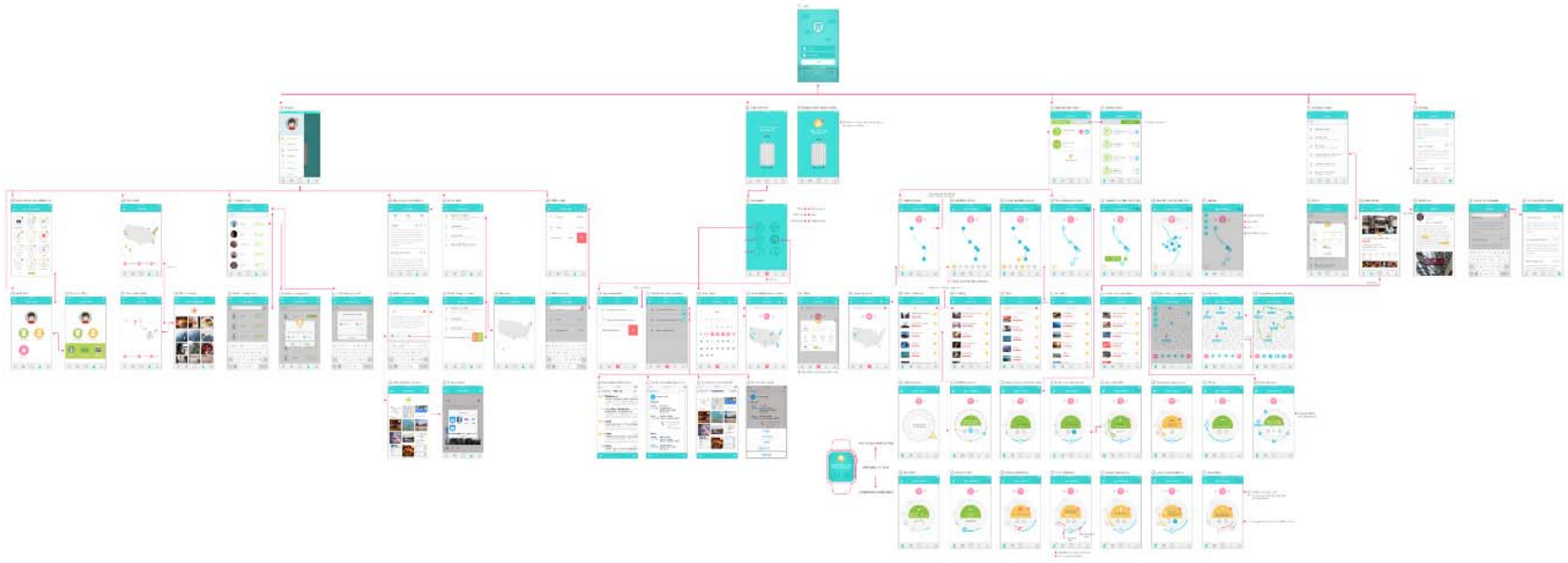


Figure 35. Developed Interface Assets of the Whole System

CHAPTER 6. EVALUATION AND REDESIGN

Granted, without an interactive demo to inspect, I believe a set of usability principles can contribute to the refinement of this information system design with visual interfaces and future work. Because SA and DCog are embodied in my design, to conduct the evaluation I chose to seek new perspectives from related theories and explorations integrating Nielsen's heuristics principles. I then set up new heuristics on the basis of benefits of heuristic evaluation and other previous design rules of InfoVis. Moreover, a card-sorting session was carried out to investigate the navigation between interfaces.

6.1 Development of a Heuristic Set

In terms of the complexity of an information display system, Pousman et al. (2006) developed four design dimensions of ambient information systems as information capacity (i.e., information trade-off between space and time), notification level (i.e., alert, signals), representational fidelity (i.e., how the data are encoded into patterns, pictures, or words), and aesthetic emphasis. They deemed that designers of information systems make decisions about how much information to display, what specific aspects to depict, and exactly how to display it (Pousman et al., 2006). Vogel et al. (2004) talked about eight principles they identified in conceptualizing an information system for public

display interaction, and the immediate usability drew my attention to the interaction and exploration between users and the app. Although every system has its own specialties, which requires unique criteria to evaluate, some principles they refer to are commonly used in various InfoVis systems. Thus referring to the theories I reviewed and what I wanted to emphasize on this design as its features, I identified and classified similar problem categories, and the 10 main heuristics were developed with several subheuristics associating with each of them (Fig. 36). The 10 main heuristics are as follows: (1) aesthetics, (2) information capacity, (3) accessibility, (4) adjustability, (5) visual representations, (6) information visualization, (7) notification level, (8) immediate usability, (9) amplify cognition, and (10) multifunctions.

Heuristic Evaluation for Travel Aiding Application

Severity ratings: **0**—no problem; **1**—cosmetic problem (Should not worry about this part.); **2**—minor problem (Slightly change should be considered.); **3**—major problem; important to fix (It is better to redesign this part.); **4**—Usability catastrophe; imperative to fix (Must redesign this part.)

Name		Your occupation	Date	Time				
Heuristics	Sub-Heuristics	Statements for Heuristics	Any other problems you find and specific recommendations you suggest	Severity Ratings (Type '√' or 'X' in the rating box.)				
				0	1	2	3	4
1. Aesthetics	Color	The color is pleasing and comfortable without distraction to use the app.						
	Consistency	The user interfaces keep consistency on its visual elements and within different themes.						
2. Information capacity	Space	The interfaces of the app contain layered but enough information to display and readable without overwhelming.						
	Time	The app can show levels of layered information at one time without distraction or missing information.						
	Scalability	By using interaction, zooming, and multiple representations (levels of detail), the application adapts to context, task, and focus.						
3. Accessibility	Planning information	The app can easily support users to access to different information of planning, such as dates, duration, destination, search/add things to do, and other information for planning a trip.						
	On-the-go information	The app can easily support user to access to on-the-go information, such as gas station, direction, notification of close time, and other contextual information that is needed for users.						
	Geographic information	The app can easily support users to access/direct to geographic information, such as looking for direction.						
4. Adjustability	Allow adjusting itinerary	The app can easily support users to adjust their itineraries, such as plans between days/in one day, before or in one trip, or explore things to do during the trip..						
5. Visual representation	Signs semiotic	The graphic and semiotic icons/elements in the app are easy to understand.						
	Representational fidelity	The visual representation of different functions is easy to understand.						
6. Information Visualization	Geographic itinerary visualization	The overview itinerary with geographic information visualized presents one itinerary clearly and intuitively.						
	Circular itinerary visualization	The circular itinerary with daily plan visualized presents one itinerary clearly and intuitively.						
7. Notification level	Alerts	The application can notify user when something happens.						
	Signals	The signals in the application are clear and straightforward.						
	Level of attention	The notification of the application is easy to catch and understand.						
8. Immediate usability	Learn by exploration	The application can be easily learned by exploration in a short time.						
	Interactivity/Interaction	The application can support potential interactivity, which is intuitive to explore.						
9. Amplify cognition	Reduce workload	The application helps to reduce mental workload before or in traveling/road trip.						
	Contextual-based suggestions	The application helps to provide contextual-based suggestions before or in traveling/road trip.						
	Control of time	In terms of wasting time on one spot, or time confliction between different spots, the application helps to manage time control in traveling/road trip.						
10.Multi-functions	Connected multi-functions	The application can connect to multi-functions outside the application that are necessary for traveling/road trips.						
	Variety	The application supports multi-functions inside the application that are necessary for traveling/road trips.						

Figure 36. Heuristic Evaluation Checklist

6.2 Data Collection and Analysis

The heuristics evaluation was then conducted as a preliminary evaluation. Each of the five recruited evaluators (Fig. 37) all had more than six years of design training, and four had experience with carrying out heuristic evaluations by themselves. Every evaluator was sent a package of ‘design brief’ of the context of use, digital interface designs of the app with wireframing and navigation links, and an evaluation checklist sheet. When working individually, they first became familiar with the design, evaluated

the product with the heuristic set, assigned ratings on the basis of Nielsen's severity rating scale (Fig. 38), and described other problems they found, which are not adhered to the principles outlined in the heuristics or specific solutions according to each heuristic when inspecting the design. The duration of completing this evaluation ranges from 45 to 60 minutes.

Evaluators	Background	Duration	Date	Place
Evaluators #1 K	3-year Graphic Designer, 4-year Industrial Design undergraduate study	45 min	09/08/2015	USA
Evaluators #2 MP	UX design expert and data visualization designer, 3-year graduate study in IXD	60 mins	09/09/2015	USA
Evaluators #3 J	Phd Student,7-year experienced Gamer designer, developer, and programmer	50 mins	09/05/2015	USA
Evaluators #4 P	3-year UX Designer, 3-year graduate study in IXD, 4-year Industrial Design undergraduate study	45 mins	09/08/2015	USA
Evaluators #5 M	Interaction Designer, 3-year graduate study in IXD, 4-year Industrial Design undergraduate study	40 mins	09/05/2015	China
Evaluators #5 L	Master student, 3-year graduate study in user experience design and programming, 4-year Industrial Design undergraduate study	60 mins	09/06/2015	USA

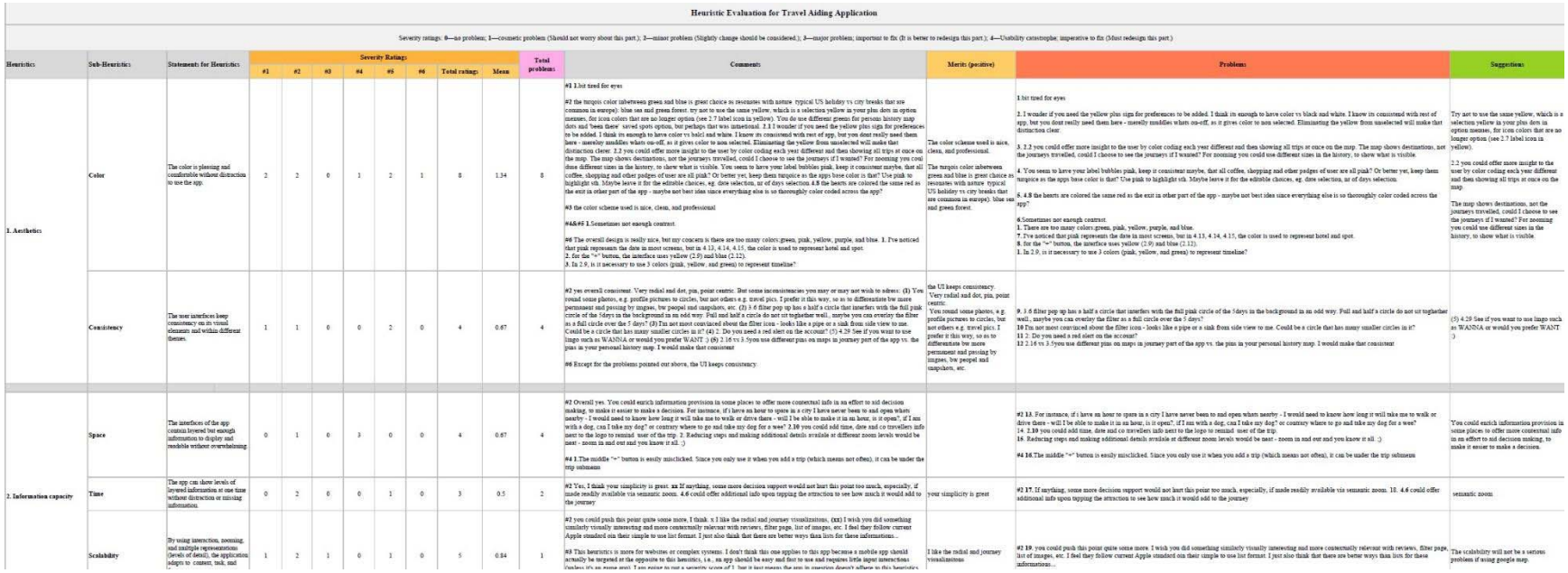
Figure 37. Screenshot of Experts' Information

Severity Ratings	
Rating	**Definition**
0	No problem (Nothing need to worry.)
1	Cosmetic problem (Have worries, but do not need to do change.)
2	Minor problem (Could be better to do slightly change for this part.)
3	Major problem; important to fix (Should be better to take consideration to redesign this part.)
4	Usability catastrophe; imperative to fix (Must redesign this part.)

Figure 38. Screenshot of Severity Ratings Scale

On the other hand, when all data of the ratings and descriptions had been collected, the data were classified as quantitative and qualitative. Quantitative data

analysis was conducted by summarizing ratings that were assigned to each heuristic and aggregating the mean ratings. Qualitative data were analyzed via categorizing problems with coded comments, suggestions, and strengths while summarizing problem descriptions and counting the number of problems that were found using each heuristic. After being summarized in Excel (Fig. 39), the ratings were calculated, and comments were divided into categories to synthesize.



Heuristic Evaluation for Travel Aiding Application

Severity ratings: 0—no problem; 1—cosmetic problem (Should not worry about this part.); 2—minor problem (Slightly change should be considered.); 3—major problem; important to fix (It is better to redesign this part.); 4—Usability catastrophe; imperative to fix (Must redesign this part.)

Heuristics	Sub-Heuristics	Statements for Heuristics	Severity Ratings								Total problems	Comments	Merits (positive)	Problems	Suggestion
			#1	#2	#3	#4	#5	#6	Total ratings	Mean					
1. Aesthetics	Color	The color is pleasing and comfortable without distraction to use the app.	2	2	0	1	2	1	8	1.34	8	#1 1.bit tired for eyes #2 the turquis color inbetween green and blue is great choice as resonates with nature typical US holiday vs city breaks that are common in europe): blue sea and green forest. try not to use the same yellow, which is a selection yellow in your plus dots in option mesnues, for icon colors that are no longer option (see 2.7 label icon in yellow). You do not different greens for persons history map dots and 'been there' saved sport option, but perhaps that was intnedinal. 2.1 I wonder if you need the yellow plus sign for predesecors to be added. I think its enough to have color vs balel and white. I know its consistend with rest of app, but you dont really need them here - merelny middles when on-off, as it gives color to non selected. Eliminating the yellow from unselected will make that distraction clever. 2.2 you could offer more insight to the user by color coding each year different and then showing all trips at once on the map. The map shows destinations, not the journeys travelled, could I choose to see the journeys if I wanted? For zooming you could thus different sizes in the history, to show what is visible. You seem to have your label bubbles pink, keep it consistent maybe, that all coffee, shopping and other pedges of user are all pink? Or better yet, keep them turquice as the apps base color is that? Use pink to highlight sth. Maybe leave it for the editable choices, eg. date selection, nr of days selection.4,5 the beatrs are colored the same red as the exit in other part of the app - maybe not best idea since everything else is so thoroughly color coded across the app? #3 the color scheme used is nice, clean, and professional #4&#6 1.Sometimes not enough contrast. #6 The overall design is really nice, but my concern is there are too many colors:green, pink, yellow, purple, and blue. 1. I've noticed that pink represents the date in most screens, but in 4.13, 4.14, 4.15, the color is used to represent hotel and spot. 2. for the "+" button, the interface uses yellow (2.9) and blue (2.12). 3. In 2.9, is it necessary to use 3 colors (pink, yellow, and green) to represent timeline?	The color scheme used is nice, clean, and professional. The turquis color inbetween green and blue is great choice as resonates with nature typical US holiday vs city breaks that are common in europe): blue sea and green forest.	1.bit tired for eyes 2. I wonder if you need the yellow plus sign for preferences to be added. I think its enough to have color vs black and white. I know its consistend with rest of app, but you dont really need them here - merelly middles when on-off, as it gives color to non selected. Eliminating the yellow from unselected will make that distraction clear. 3. 2.2 you could offer more insight to the user by color coding each year different and then showing all trips at once on the map. The map shows destinations, not the journeys travelled, could I choose to see the journeys if I wanted? For zooming you could use different sizes in the history, to show what is visible. 4. You seem to have your label bubbles pink, keep it consistent maybe, that all coffee, shopping and other pedges of user are all pink? Or better yet, keep them turquice as the apps base color is that? Use pink to highlight sth. Maybe leave it for the editable choices, eg. date selection, nr of days selection. 5. 4,5 the beatrs are colored the same red as the exit in other part of the app - maybe not best idea since everything else is so thoroughly color coded across the app? 6.Sometimes not enough contrast. 1. There are too many colors:green, pink, yellow, purple, and blue. 7. I've noticed that pink represents the date in most screens, but in 4.13, 4.14, 4.15, the color is used to represent hotel and spot. 8. for the "+" button, the interface uses yellow (2.9) and blue (2.12). 1. In 2.9, is it necessary to use 3 colors (pink, yellow, and green) to represent timeline?	Try not to use the same yellow, which is a selection yellow in your plus dots in option mesnues, for icon colors that are no longer option (see 2.7 label icon in yellow). 2.2 you could offer more insight to the user by color coding each year different and then showing all trips at once on the map. The map shows destinations, not the journeys travelled, could I choose to see the journeys if I wanted? For zooming you could use different sizes in the history, to show what is visible.
	Consistency	The user interfaces keep consistency on its visual elements and within different themes.	1	1	0	0	2	0	4	0.67	4	#2 yes overall consistent. Very radial and dot, pin, point centric. But some inconsistencies you may or may not wish to adress: (1) You round some photos, e.g. profile pictures to circles, but not others e.g. travel pics. I prefer it this way, so as to differeantiate bw more permanent and passing by imgines, bw peopal and snapshots, etc. (2) 3.6 filter pop up has a half a circle that interfers with the full pink circle of the 5days in the background in an odd way. Full and half a circle do not sit togheather well., maybe you can overlay the filter as a full circle over the 5 days? (3) I'm not most convinced about the filter icon - looks like a pipe or a sink from side view to me. Could be a circle that has many smaller circles in it? (4) 2. Do you need a red alert on the account? (5) 4.29 See if you want to use lingo such as WAINIA or would you prefer WANT ;) (6) 2.16 vs 3.5you use different pins on maps in journey part of the app vs. the pins in your personal history map. I would make that consistent #6 Except for the problems pointed out above, the UI keeps consistency.	the UI keeps consistency. Very radial and dot, pin, point centric You round some photos, e.g. profile pictures to circles, but not others e.g. travel pics. I prefer it this way, so as to differeantiate bw more permanent and passing by imgines, bw peopal and snapshots, etc.	9. 3.6 filter pop up has a half a circle that interfers with the full pink circle of the 5days in the background in an odd way. Full and half a circle do not sit togheather well., maybe you can overlay the filter as a full circle over the 5 days? 10 I'm not most convinced about the filter icon - looks like a pipe or a sink from side view to me. Could be a circle that has many smaller circles in it? 11 2. Do you need a red alert on the account? 12 2.16 vs 3.5you use different pins on maps in journey part of the app vs. the pins in your personal history map. I would make that consistent	(5) 4.29 See if you want to use lingo such as WAINIA or would you prefer WANT ;)
2. Information capacity	Space	The interfaces of the app contain layered but enough information to display and readable without overwhelming	0	1	0	3	0	0	4	0.67	4	#2 Overall yes. You could enrich information provision in some places to offer more contextual info in an effort to aid decision making, to make it easier to make a decision. For instance, if i have an hour to spare in a city I have never been to and open whats nearby - I would need to know how long it will take me to walk or drive there - will I be able to make it in an hour, is it open?, if I am with a dog, can I take my dog? or courtney where to go and take my dog for a wee? 2.10 you could add time, date and co travellers info next to the logo to remind user of the trip. 2. Reducing steps and making additional details available at different zoom levels would be neat - zoom in and out and you know it all. :) #4 1.The middle "+" button is easily misclicked. Since you only use it when you add a trip (which means not often), it can be under the trip submenu		#2 13. For instance, if i have an hour to spare in a city I have never been to and open whats nearby - I would need to know how long it will take me to walk or drive there - will I be able to make it in an hour, is it open?, if I am with a dog, can I take my dog? or courtney where to go and take my dog for a wee? 14 2.10 you could add time, date and co travellers info next to the logo to remind user of the trip. 15. Reducing steps and making additional details available at different zoom levels would be neat - zoom in and out and you know it all. :) #4 16.The middle "+" button is easily misclicked. Since you only use it when you add a trip (which means not often), it can be under the trip submenu	You could enrich information provision in some places to offer more contextual info in an effort to aid decision making, to make it easier to make a decision.
	Time	The app can show levels of layered information at one time without distraction or missing information.	0	2	0	0	1	0	3	0.5	2	#2 Yes, I think your simplicity is great. xx If anything, some more decision support would not hurt this point too much, especially, if made readily available via semantic zoom. 4.6 could offer additional info upon tapping the attraction to see how much it would add to the journey	your simplicity is great	#2 17. If anything, some more decision support would not hurt this point too much, especially, if made readily available via semantic zoom. 18. 4.6 could offer additional info upon tapping the attraction to see how much it would add to the journey	semantic zoom
	Scalability	By using interaction, zooming, and multiple representations (levels of detail), the application adapts to content, task, and	1	2	1	0	1	0	5	0.84	1	#1 you could push this point quite some more. I think. x I like the radial and journey visualizations. (xx) I wish you did something similarly visually interesting and more contextually relevant with reviews, filter page, list of images, etc. I feel they follow current Apple standard on their simple to use list format. I just also think that there are better ways than lists for these informations... #3 This heuristics is more for websites or complex systems. I don't think this one applies to this app because a mobile app should actually be targeted at the opposite to this heuristics, i.e., an app should be easy and fast to use and requires little input interactions (unless it's an game app). I am going to put a seriously 'score of 1' but it just means the app in question doesn't adhere to this heuristics	I like the radial and journey visualizations	#2 19. you could push this point quite some more. I wish you did something similarly visually interesting and more contextually relevant with reviews, filter page, list of images, etc. I feel they follow current Apple standard on their simple to use list format. I just also think that there are better ways than lists for these informations...	The scalability will not be a serious problem if using google map.

Figure 39. Screenshot of Heuristic Evaluation Summary

6.3 Results

A review of the checklists found a total of 73 problems referring to the large amount of user interfaces in the evaluation package. Some evaluators found many more problems than the others, and problems were categorized again with similar focuses. The severity ratings and mean ratings of each heuristic are shown in Fig. 40.

Heuristic Evaluation for Travel Aiding Application

Heuristics	Sub-Heuristics	Total	Mean ratings	Total problems
1. Aesthetics	Color	8	1.34	8
	Consistency	4	0.67	4
2. Information Capacity	Sapce	4	0.67	4
	Time	3	0.5	2
	Scalability	5	0.84	1
3. Accessibility	Planning information	7	1.17	8
	On-the-go information	8	1.34	6
	Geographic information	6	1	1
4. Adjustability	Allow adjusting itinerary	8	1.34	3
5. Visual representation	Signs semiotic	9	1.5	9
	Representational fidelity	8	1.34	5
6. Information Visualization	Geographic itinerary visualization	12	2	4
	Circular itinerary visualization	9	1.5	2
7. Notification level	Alerts	5	0.84	2
	Signals	6	1	2
	Level of attention	6	1	2
8. Immediate usability	Learn by exploration	5	0.84	1
	Interactivity/Interaction	2	0.34	2
9. Amplify cognition	Reduce workload	9	1.5	2
	Contextual-based suggestions	3	0.5	1
	Control of time	4	0.67	2
10. Multi-functions	Connected multi-functions	5	0.84	1
	Variety	2	0.34	2

Figure 40. Screenshot of Ratings and Problems Summary

On the basis of rating scales, the ratings of 2 or more than 2 indicate a part that needs to be redesigned. Therefore the heuristics with mean ratings of more than 1 were what I focused on for redesign, which would affect the app user experience when traveling. Those heuristics were identified according to the ranking of severity ratings as listed below:

[H6 Information Visualization] [H6-1 Geographic itinerary visualization] [Mean Severity: 2]
[H5 Visual representation] [H5-1 Signs semiotic] [Mean Severity: 1.5]
[H6 Information Visualization] [H6-2 Circular itinerary visualization] [Mean Severity: 1.5]
[H9 Amplify cognition] [H9-1 Reduce workload] [Mean Severity: 1.5]
[H1 Aesthetics] [H1-1 Color] [Mean Severity: 1.34]
[H3 Accessibility] [H3-2 On-the-go information] [Mean Severity: 1.34]
[H4 Adjustability] [Mean Severity: 1.34]
[H5 Visual representation] [H5-2 Representational fidelity] [Mean Severity: 1.34]
[H3 Accessibility] [H3-1 Planning information] [Mean Severity: 1.17]
[H3 Accessibility] [H3-3 Geographic information] [Mean Severity: 1]
[H7 Notification level] [H7-2 Signals] [Mean Severity: 1]
[H7 Notification level] [H7-3 Level of attention] [Mean Severity: 1]
[H2 Information capacity] [H2-3 Scalability] [Mean Severity: 0.84]
[H7 Notification level] [H7-1 Alerts] [Mean Severity: 0.84]
[H8 Immediate usability] [H8-1 Learn by exploration] [Mean Severity: 0.84]
[H10 Multifunctions] [H10-1 Connected multifunctions] [Mean Severity: 0.84]
[H1 Aesthetics] [H1-2 Consistency] [Mean Severity: 0.67]
[H2 Information capacity] [H2-1 Space] [Mean Severity: 0.67]
[H9 Amplify cognition] [H9-3 Control of time] [Mean Severity: 0.67]
[H2 Information capacity] [H2-2 Time] [Mean Severity: 0.5]
[H9 Amplify cognition] [H9-2 Contextual-based suggestions] [Mean Severity: 0.5]
[H8 Immediate usability] [H8-2 Interactivity or Interaction] [Mean Severity: 0.34]
[H10 Multifunctions] [H10-2 Variety] [Mean Severity: 0.34]

Relevant problem comments were then selected, categorized as usability, colors, icons and buttons, notification, circular visualization, geographic visualization, filters, UX, off-line map, and other suggestions. Below is the organized redesign suggestion list:

(1) Colors are slightly overwhelming and somehow not differentiated enough.
(2) Icons need descriptions because some are hard to understand.
(3) Could add different summaries illustrated as the icon instead of only luggage (e.g.: lists, weight, packed items).
(4) Confusion about the two circles in circular visualization (cue words, needed service with membership).
(5) Could merge the map with the abstract geographic visualizations.
(6) Enrich information provision in some places to offer more contextual info to aid decisions, making them easier. (I have one hour to spare. What else I can do?)

(7) Add time, distance, mileage, or cost details to help users make decisions when planning.
(8) Show time constraint when adding other points of interest.
(9) Enhance the relationship between POIs and the time-based visualization simultaneously. If I had saved a place to visit, it should pop up as a recommendation if I find it nearby.
(10) Category-based destinations. Filters need more categories, such as travel with a dog, holidays, and break times.
(11) Categorize the saved stops with preferences, such as private, public, to be visited, already visited, and to be recommended.
(12) Invite a partner-editor through Facebook, message texts, and other means.
(13) Others:
    (a) Pull contacts directly from user phones or Facebook so they toned not make a new list of friends and contacts.
    (b) I wish you did something similarly visually interesting and more contextually relevant with reviews, filter page, list of images, and more.

Several functions were also missed by experts when reviewing the design: synchronization, stored points of interest, connection to other apps, how to replace points of interest, and how to move a point of interest to a different date and time. In terms of addressing the main value package of the new travel-aid system, a redesign section was arranged to improve the current design and user experience based on experts' suggestions.

6.4 Discussion and Redesign

Most of the results showed that the system is creative and convenient, which improves flexibility of travel planning and adjusting, and the contextual notification could enhance SA while easily fitting into various contexts being used. Although some minor problems that need revision are listed in the previous chapter, the strengths of design are consistency, the user experience of planning with friends and adjusting the itinerary, creativity of the circular visualization, the synchronization function, suggestions

on time control and contextual information, and how users can plan the order of visiting by themselves. The weakness pointed to the visual representation, the effectiveness of information visualization, and how to amplify user cognition by enriching the information capability.

To fix the problems identified in the current design while reiterating and strengthening the travel experience section, I decided to focus on the redesign in the directions of color scheme, graphic design, visualization, and user experience. First, with the quite large capability and variety of functions on the app, I aimed at the basic color codes that are applied throughout the system to avoid distraction and an overwhelming effect. Second, according to the visual representation of the icons in terms of both originality and universality, I added descriptions on the menu icons and the specific icons that were based on context of the app (Figs. 41-43).

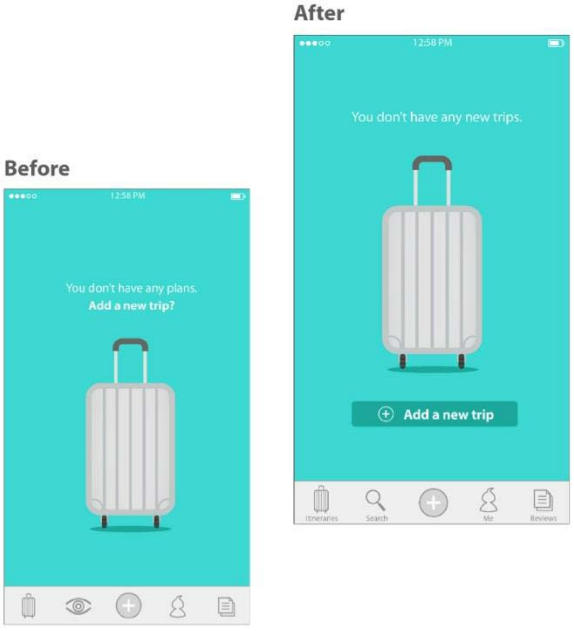


Figure 41. Enhancing the Affordance and Organization of Buttons

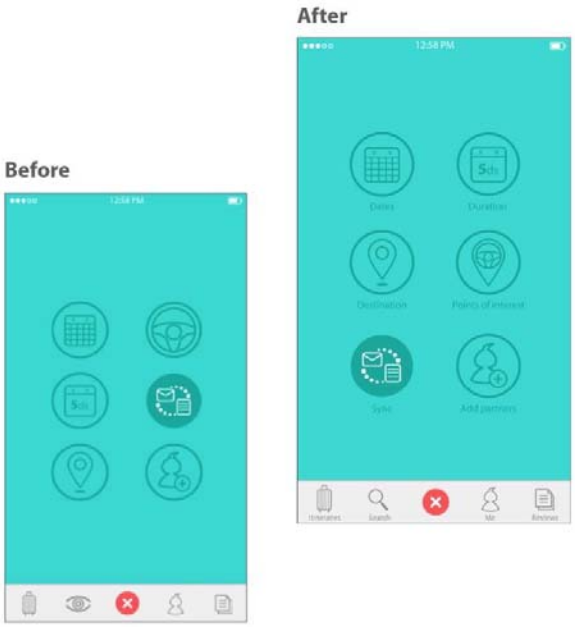


Figure 42. Adding Descriptions of the Icons

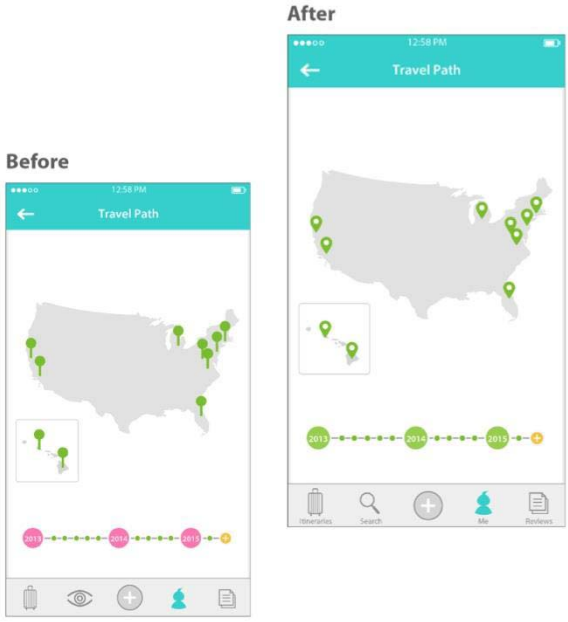


Figure 43. Reorganization of Icons and Color Scheme

Then to enhance the relationship between the time-based visualization and current itinerary, suggestions such as adding time, distance, mileage, or cost details to aid

decision making when planning were adopted to show time constraint when adding another point of interest in route (Fig. 44). By that means, it would be easier for users to make decisions with the enriched contextual information. For instance, if the users have an hour to spare, they could find the information of what else they can do, or if they had saved a place to visit, that place should pop up as a recommendation if the users are nearby.

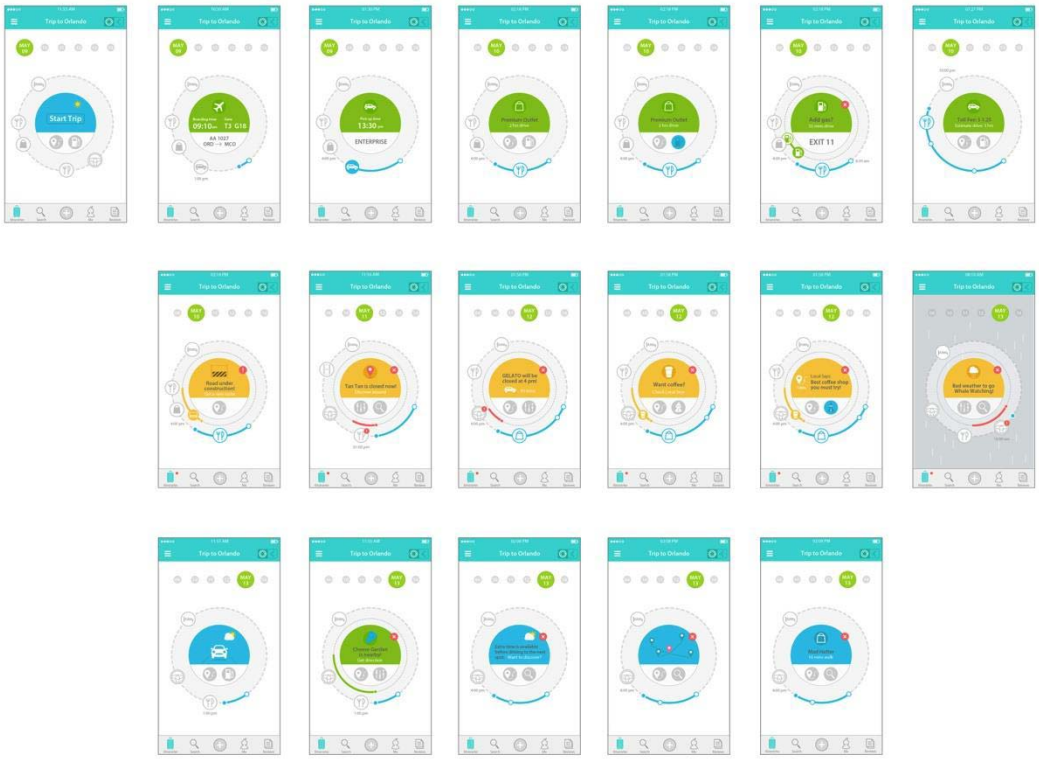


Figure 44. Contextual Notification of Time-Based Activities

On the other hand, even with information visualization no matter how simply the design and user experience could be reached, the geographic map is still necessary to apply and merge with abstract visualizations as a tool (Fig. 45). The icon of adding a point of interest was moved to the menu bar (Fig. 46). To improve this travel-aid system as a whole, the user experience of other graphic design and interaction design

perspectives then weighs equally with the visualization concept. To enhance the user experience of the whole system, experts deemed that category-based information would reduce user workload, such as category-based destinations and saved places, filters with holidays, and break times (Figs. 47-50).

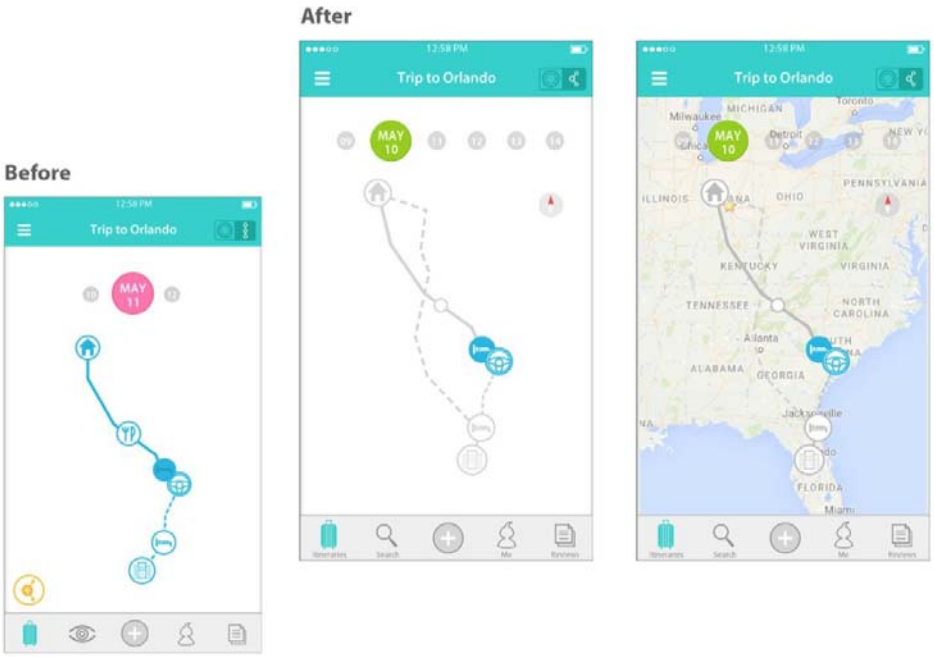


Figure 45. Geographic Map of Trip Overview

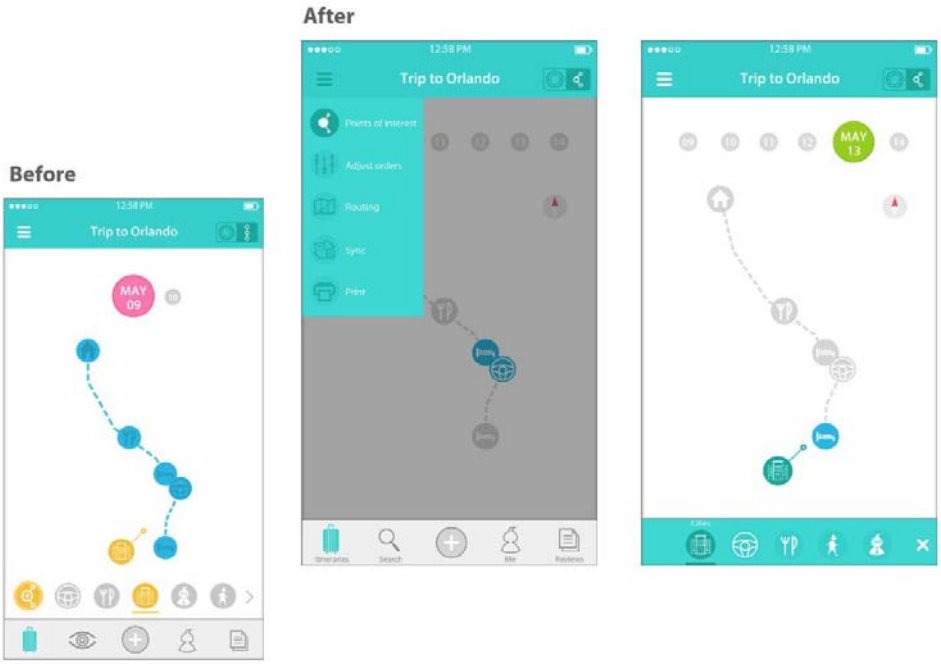


Figure 46. Grouping of the Functions

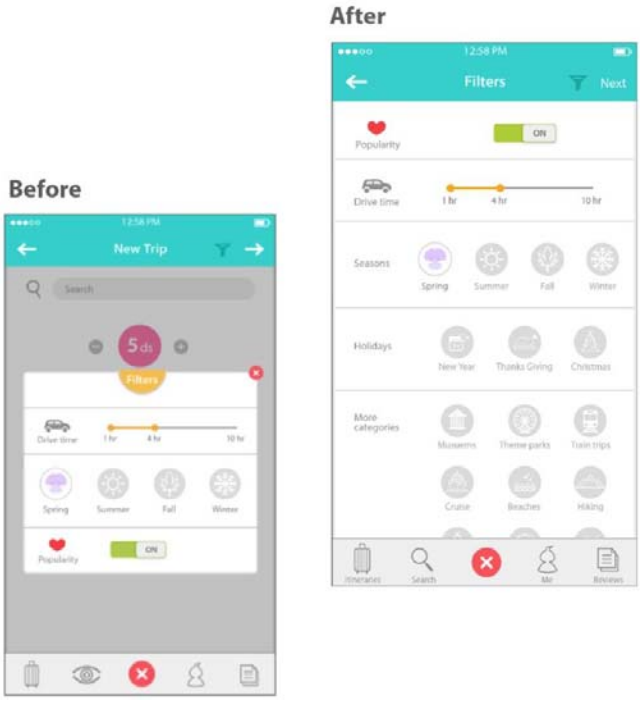


Figure 47. Categories Filters When Planning

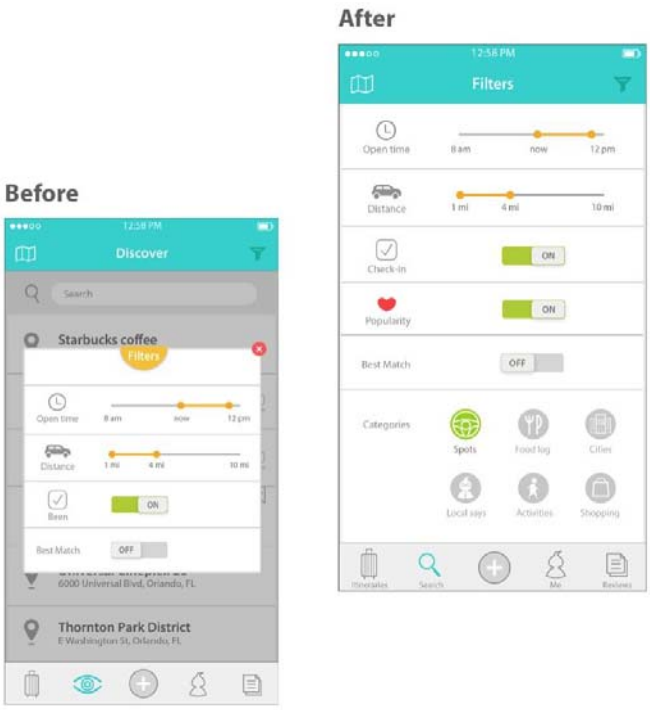


Figure 48. Categories Filters When Searching

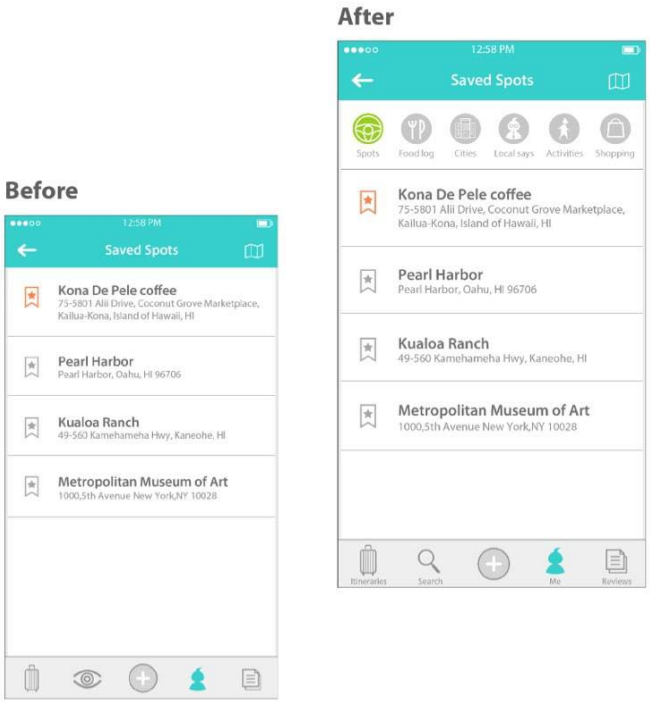


Figure 49. Categories of Saved Places

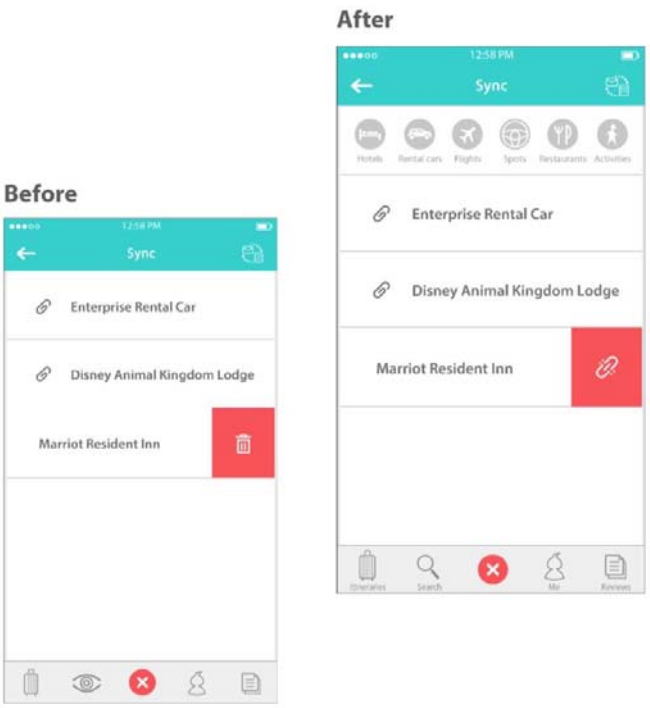


Figure 50. Categories of Synchronized Information

As an essential service of business strategy, connecting to the membership of different services in reality would contribute to the value proposition. Furthermore, inviting travel partners through other social media or even contacts was brought up (Fig. 51), and so was adding different summaries illustrated as the icon on itinerary lists (Fig. 52). Lastly, the function of reserving a stop (e.g., restaurant or attraction) automatically based on the current itinerary was added (Fig. 53).

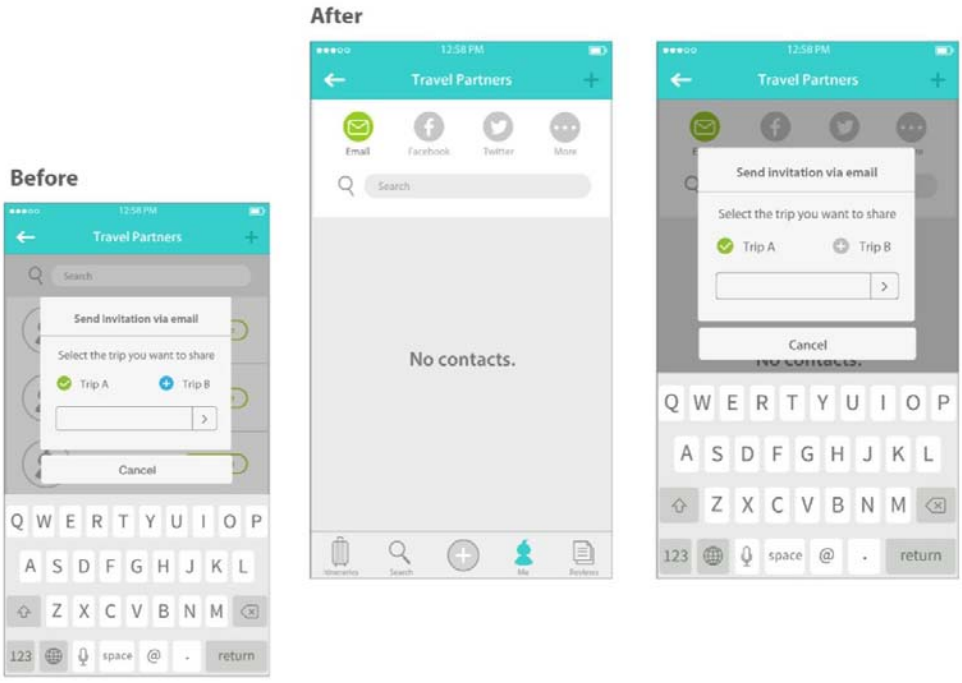


Figure 51. Connecting to Contacts to Add Travel Partners

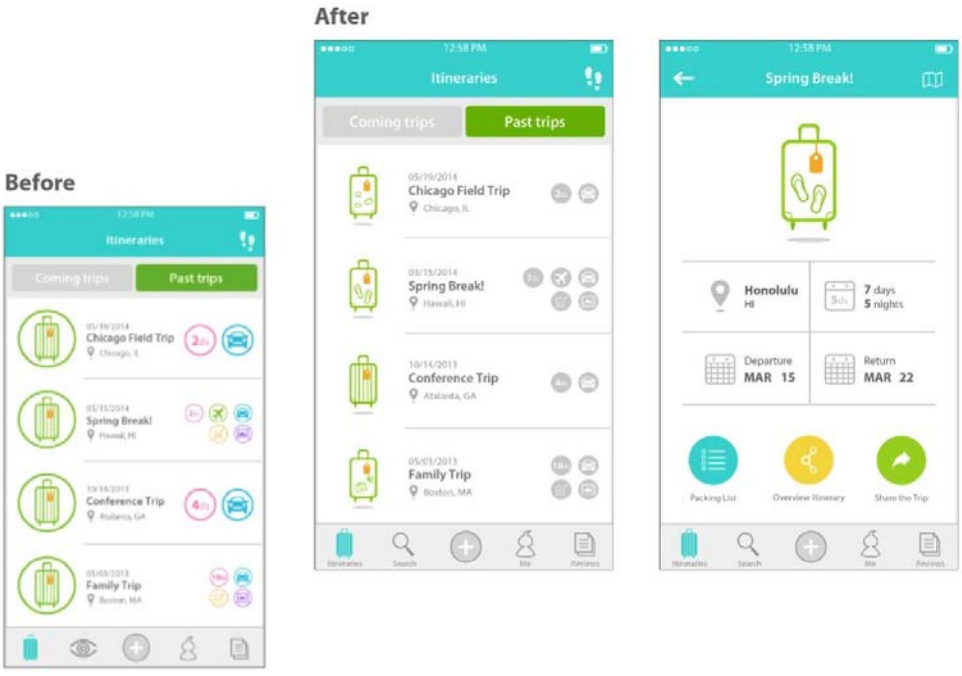


Figure 52. Summaries of Upcoming Trips and Past Trips

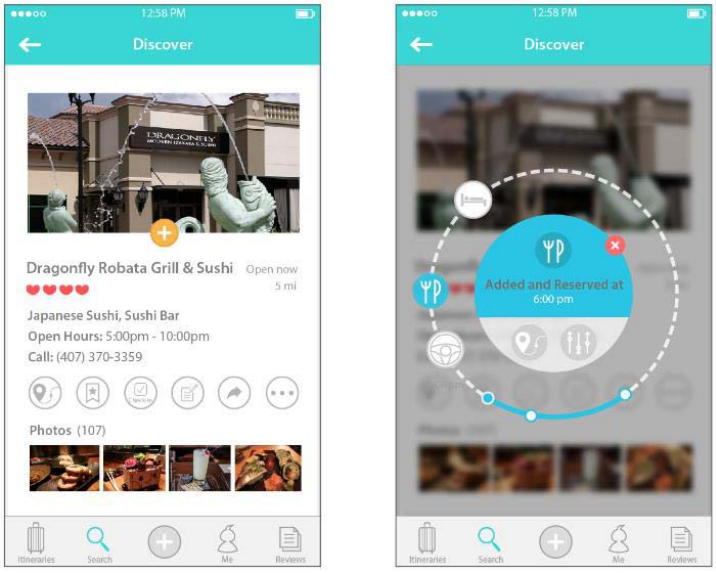


Figure 53. Reserving a Place to Stop Based on Current Itinerary

Nevertheless, several perspectives could be taken into consideration as new values in future work. For example, experts mentioned the driver mode, which would be useful for safe driving. As for planning together with friends, the way of how to compare plans with travel partners could also be developed. Comments like reviews with contextual visual representation and adding something outside the app to the current plan were not included in this redesign session, but they could be integrated to improve the variety of the app.

Besides redesigning the graphic assets, as I mentioned earlier, I also conducted card sorting in a small interaction design group to test the navigation and work flow with low-fidelity paper prototype (Fig. 54). Post-it notes were written for further improvement reference. After all the layouts and navigation were edited, I used Invision, an online prototyping Web site, to integrate all the existing interfaces and create an interactive demo as a demonstration of the new travel experience. The redesigned entire system is

presented in Figs. 56, 57, and 58, and the final business strategy was refined as depicted in Fig. 55, linking service with new values.

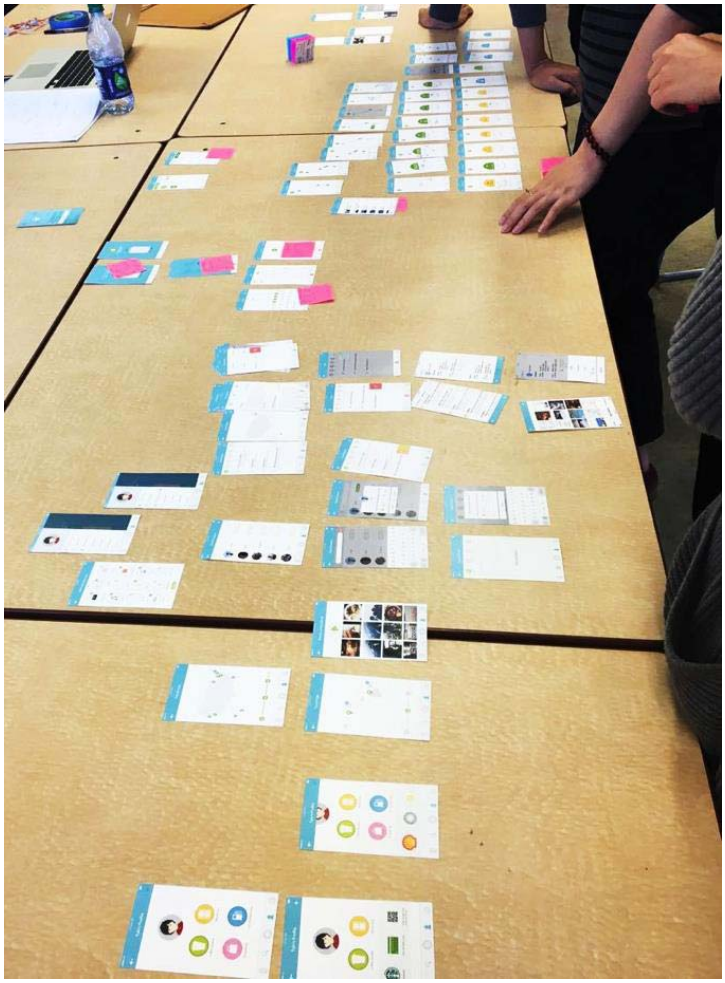


Figure 54. Card Sorting

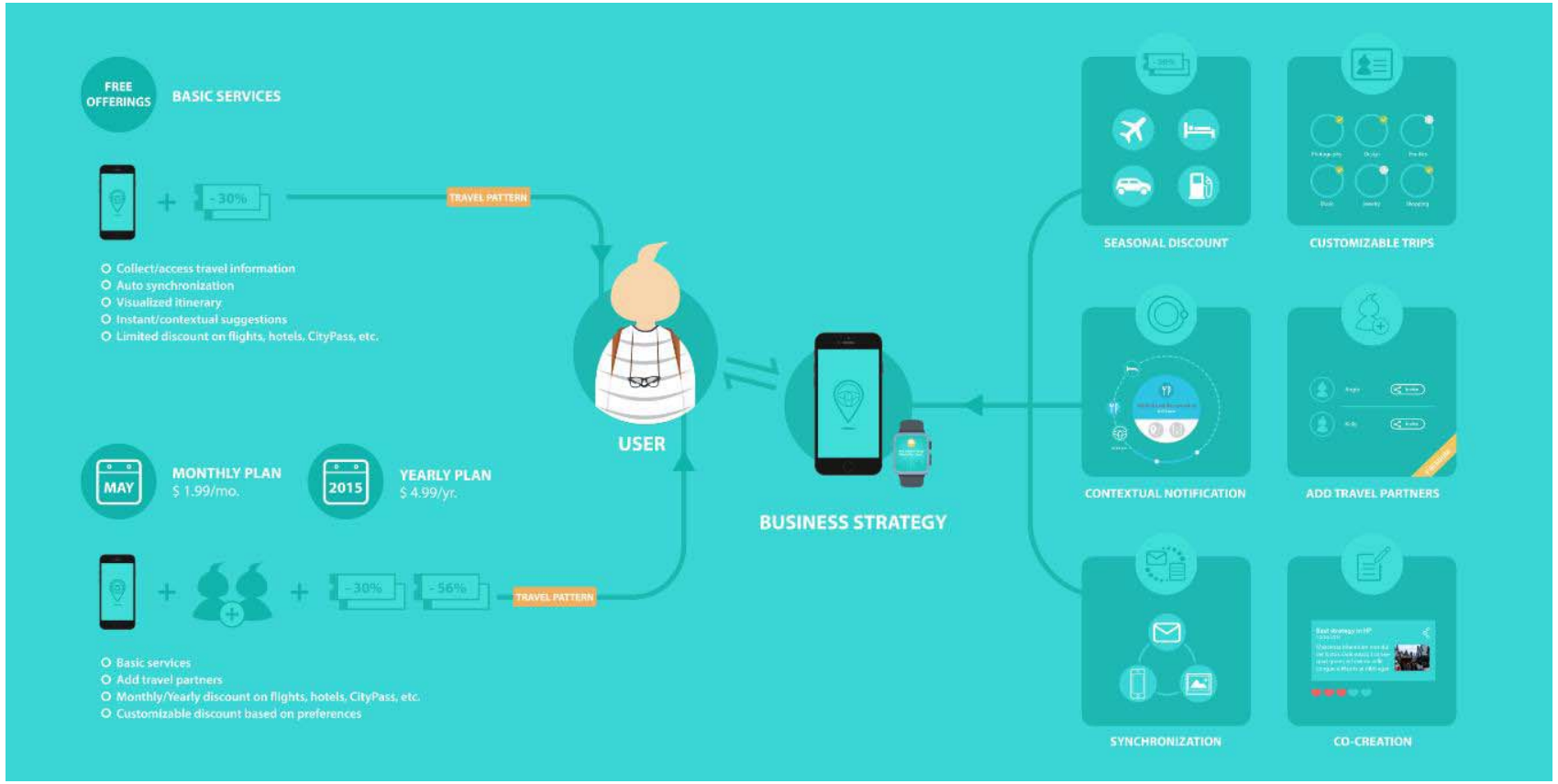


Figure 55. Final Business Strategy

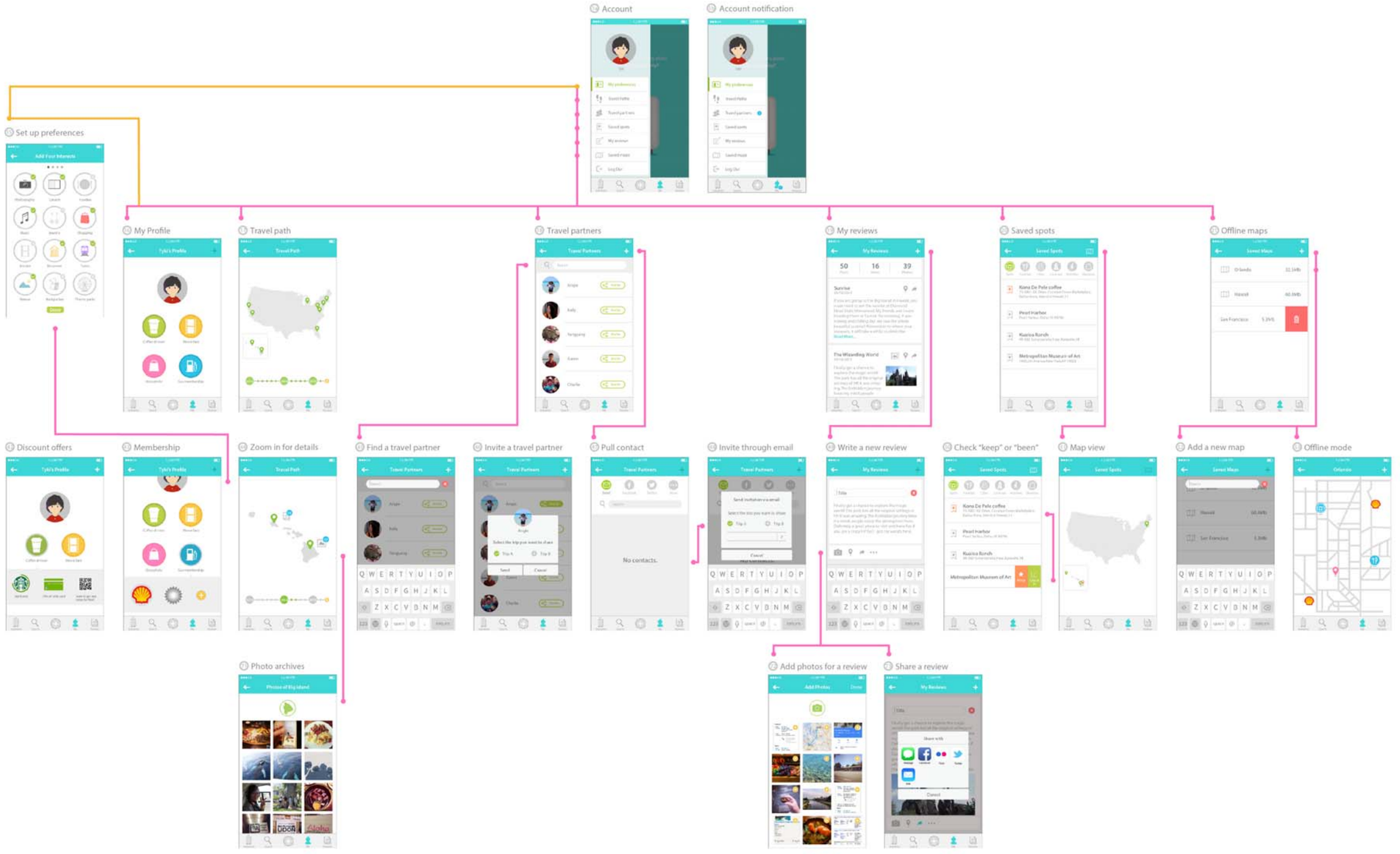


Figure 56. Redesign of the Interface Assets Part 1

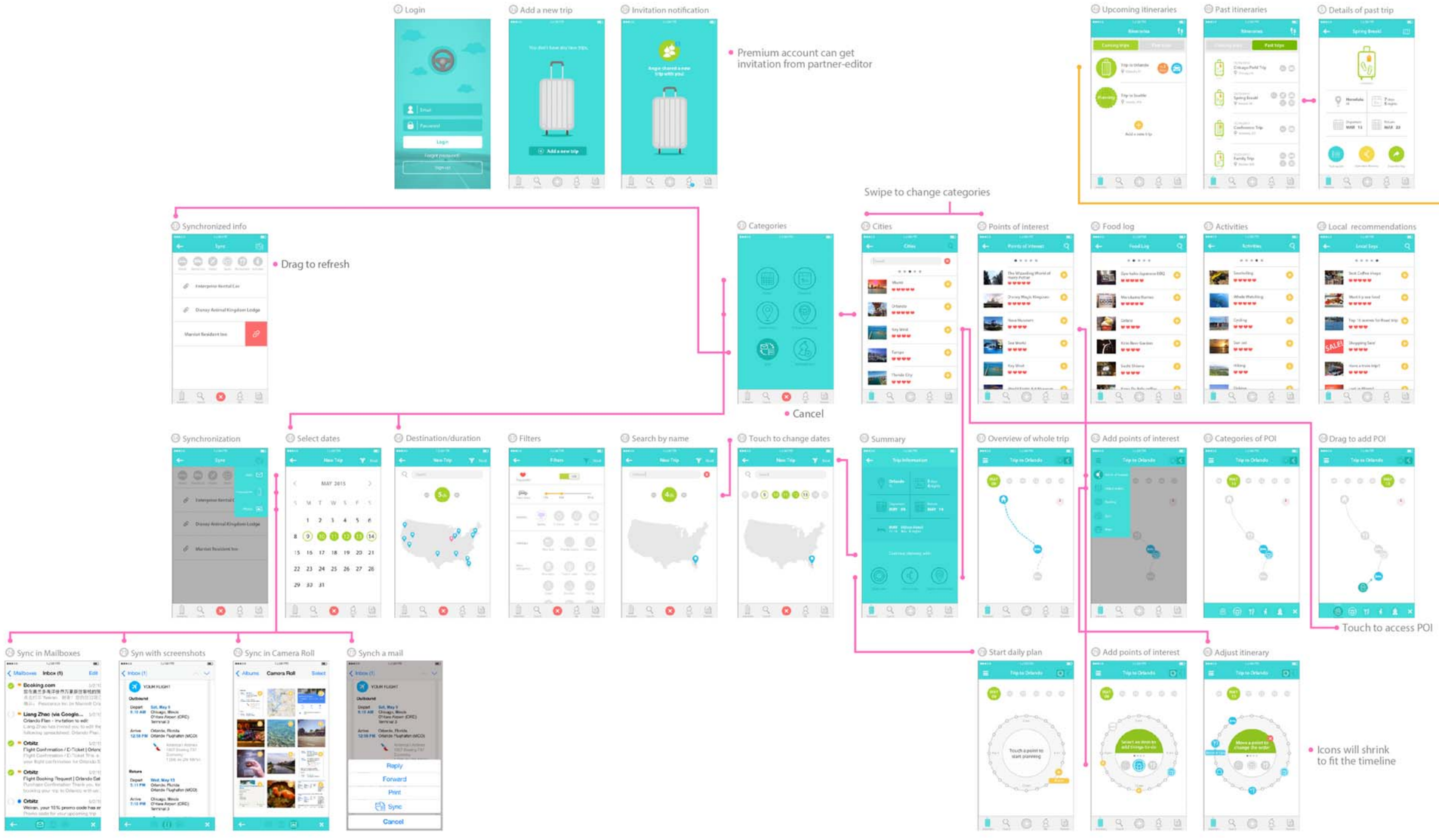


Figure 57. Redesign of the Interface Assets Part 2

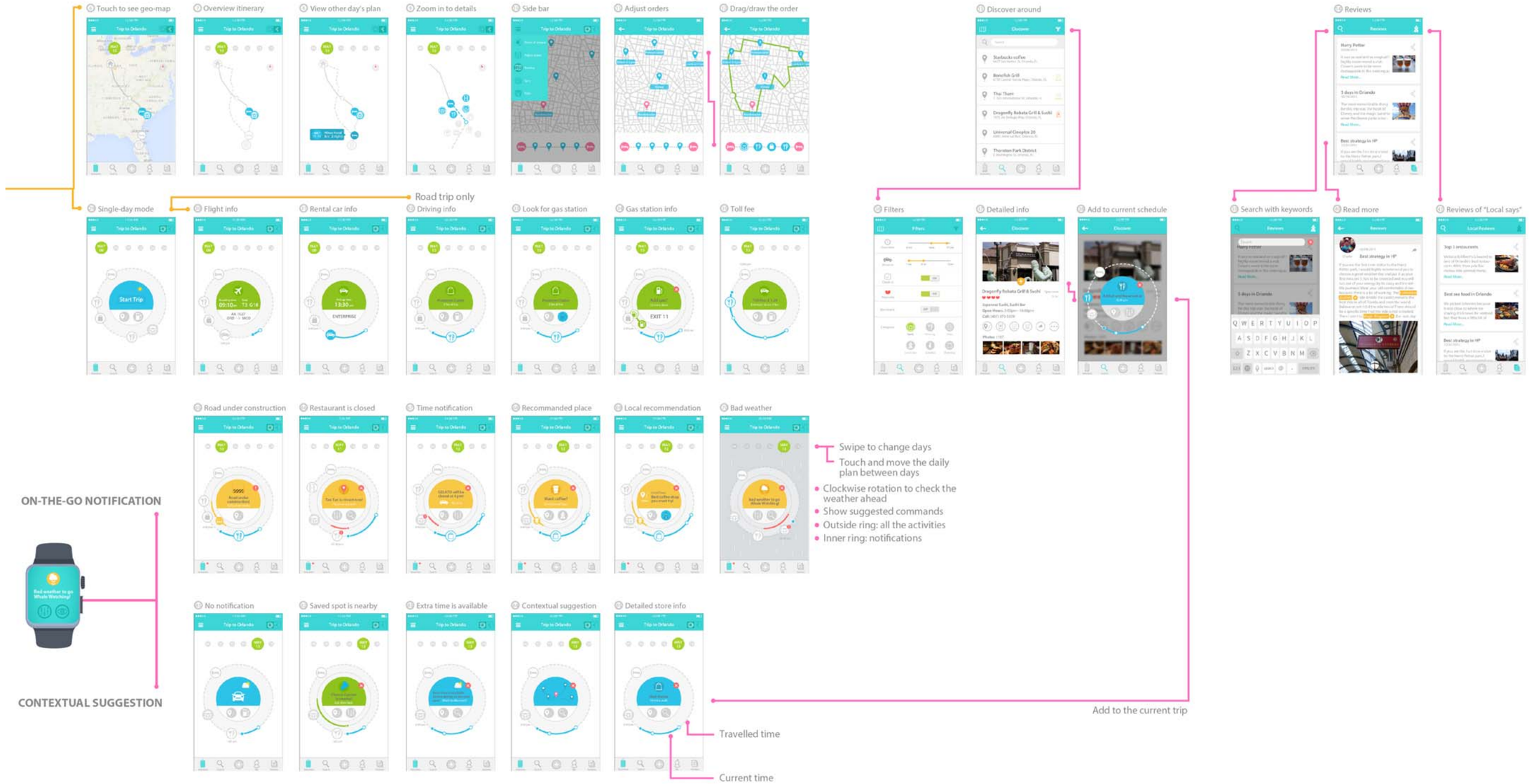


Figure 58. Redesign of the Interface Assets Part 3

CHAPTER 7. CONCLUSION

The essence of design[2] lies in the process of discovering a problem shared by most of the people who are trying to solve it. Since design aims at a better life, or to be more specific, a simpler life with more conveniences, an interrelationship develops between audience acceptance and designer intention. Especially in the current era of user-centered design, the considerations of user experience have become increasingly significant because of what audiences can pursue, what they can experience through using the products and services, perceptions of visual communication are varied and enhanced through technology, transition of ideology among society, and similar developments.

This thesis was inspired by my own road trip experience under different travel contexts, and the issues I met and wanted to solve. As an individual design development, even though tones of research had been done to generalize its execution of design, inadequate factors did affect the final results. To improve the validity, literature reviews

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[2] Hara Kenya points out that design, is basically not self-expression. Instead, it originates in society. The essence of design lies in the process of discovering a problem shared by many people and trying to solve it. Because the root of the problem is within society, everyone can understand plans for solutions and processes to solve the problem, and they are able to see the problem from the designer's perspective. Design is appealing because the process creates inspiration engendered by this empathy among human beings in our common values and spirituality. (*Designing Design* p. 24, Baden, Switzerland: Lars Muller Verlag, 2011)

built the foundation of the theoretical connections. Via practice at “being a tourist” to conceive tourism experiences, I strengthened the empathetic connection between designer and users. By investigating potential users, I learned that traveler issues and insights of a road trip structured the potential design opportunities in consideration of solutions from their points of view. The data collection and analysis provided the literature evidence while generating design direction. More significantly, as I discussed, design can represent how people’s pursuits can be presented and realized by translating current needs into designed representations that appeal to user expectations. The final design tried to connect instant information with traveler under the travel context; a smartphone app was designed to recontextualize situation awareness and distributed cognition into the travel-aiding system while visualizing the information that a user desires or expects before and during a road trip. Furthermore, when thinking outside the box I realized that except for interaction with the system, which affects user experience from a design perspective, the interaction with the physical smartphone also mutually affects the design that should be improved at the same level.

In conclusion, this thesis mainly focuses on visual representations being essential aids to human cognitive tasks and their value to application in the travel-aid system with visualized information. Enhanced situation awareness can contribute to the amplification of user experience (with more perception and acceptability), and the distributed cognition can be supported with contextual-based information visualization. Last but not least, by developing cohesive criteria to evaluate the design, I examined limitation and lack of consideration on implementing design, which brought up the need to redesign for refinement.

Considering that technology development is promoting our material culture by shaping the processes and patterns of communication when judging it from the interaction design field, I find that the design concept of "sell people on the idea of…." with business perspective is extremely needed and helpful. Because people's desires are not only to see how creative the solution or the advanced technical performance is, what makes design fresh, acceptable, and long-lasting is the upgrading of values, forms, and related connections between products and services and the functions they have, which contribute to better user experience while demonstrating the progress they have reached.

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APPENDIX

APPENDIX: IRB Approval

PURDUE
UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	ZHEN YU QIAN PAO
From:	JEANNIE DICLEMENTI, Chair Social Science IRB
Date:	02/25/2015
Committee Action:	Exemption Granted
IRB Action Date:	02/24/2015
IRB Protocol #:	1502015770
Study Title:	Interview and online survey on travel planning, travel experience and issues

The Institutional Review Board (IRB) has reviewed the above-referenced study application and has determined that it meets the criteria for exemption under 45 CFR 46.101(b)(2) .

If you wish to make changes to this study, please refer to our guidance "Minor Changes Not Requiring Review" located on our website at http://www.irb.purdue.edu/policies.php. For changes requiring IRB review, please submit an Amendment to Approved Study form or Personnel Amendment to Study form, whichever is applicable, located on the forms page of our website www.irb.purdue.edu/forms.php. Please contact our office if you have any questions.

Below is a list of best practices that we request you use when conducting your research. The list contains both general items as well as those specific to the different exemption categories.

General

- To recruit from Purdue University classrooms, the instructor and all others associated with conduct of the course (e.g., teaching assistants) must not be present during announcement of the research opportunity or any recruitment activity. This may be accomplished by announcing, in advance, that class will either start later than usual or end earlier than usual so this activity may occur. It should be emphasized that attendance at the announcement and recruitment are voluntary and the student's attendance and enrollment decision will not be shared with those administering the course.
- If students earn extra credit towards their course grade through participation in a research project conducted by someone other than the course instructor(s), such as in the example above, the students participation should only be shared with the course instructor(s) at the end of the semester. Additionally, instructors who allow extra credit to be earned through participation in research must also provide an opportunity for students to earn comparable extra credit through a non-research activity requiring an amount of time and effort comparable to the research option.
- When conducting human subjects research at a non-Purdue college/university, investigators are urged to contact that institution's IRB to determine requirements for conducting research at that institution.
- When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without

proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Category 1

- When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Categories 2 and 3

- Surveys and questionnaires should indicate
  - only participants 18 years of age and over are eligible to participate in the research; and
  - that participation is voluntary; and
  - that any questions may be skipped; and
  - include the investigator's name and contact information.
- Investigators should explain to participants the amount of time required to participate. Additionally, they should explain to participants how confidentiality will be maintained or if it will not be maintained.
- When conducting focus group research, investigators cannot guarantee that all participants in the focus group will maintain the confidentiality of other group participants. The investigator should make participants aware of this potential for breach of confidentiality.
- When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). This is an institutional requirement.

Category 6

- Surveys and data collection instruments should note that participation is voluntary.
- Surveys and data collection instruments should note that participants may skip any questions.
- When taste testing foods which are highly allergenic (e.g., peanuts, milk, etc.) investigators should disclose the possibility of a reaction to potential subjects.